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# COST ACCOUNTANTS' HANDBOOK

Edited by  
THEODORE LANG, M B A , C P A  
Professor of Accounting, New York University

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## PREFACE

Modern cost accounting is a major field in its own right. Its sphere of activity, carved out for itself in this generation stands midway between those of the general accountant and the engineer. Considerable literature of the science now exists in large measure due to the activities of the National Association of Cost Accountants in promoting the development of cost accounting. The time therefore, has come to put into the hands of all those interested in cost accounting a codification of its principles and techniques in organized, accessible, readily usable form.

This entire Handbook deals primarily with cost accounting for manufacturing industries. It is in this field that cost accounting has attained its greatest development and maturity. Within this framework the Handbook develops the fundamental principles of cost accounting and presents the methods and techniques that cost accountants have worked out and found useful. The usefulness of the material, however, extends to others than the cost accountant. These include the engineer, the production staff, the general accountant and the manager, each of whom to an increasing extent is being brought into contact with cost data. Their interests and needs are given due recognition in the presentation of the material throughout the Handbook.

Proof of the basic soundness of modern cost accounting is conclusively furnished by the manner in which it has adapted itself almost effortlessly to wartime requirements. Such changes as have been brought about in cost techniques are for the most part the result of statutory requirements and administrative rulings. These are purely temporary conditions which may pass when the war is ended. The principles of cost accounting have experienced no changes and remain the same, war or no war.

The task of the editor has been made measurably easier by the active cooperation and assistance of the contributing and consulting editors. The former group has been drawn largely from the educational field, men experienced in research in assembling material, and presenting it in logical and authoritative form, all this in addition to their practical experience. The second group consists of the consulting editors, men of affairs placed in responsible positions in the fields of professional accounting, industrial accounting, and education. They have brought to the task of passing upon the manuscripts a counsel of experience and

practical knowledge not available otherwise. The combination of educational and industrial background of the material in this Handbook should make it authoritative, both in its manner of presentation and in the subject matter covered.

To the editor it has been one of the intangible compensations and a never ending source of wonder to observe how executives with enormous responsibilities enhanced by the war effort have nevertheless taken time to review manuscripts, make exhaustive comments, and even furnished illustrative material from their own work. To these men the editor can but tender his wholehearted thanks, fully realizing the inadequacy of thanks for such unselfish services. The editor wishes also to give specific recognition to the work and invaluable aid of contributors who have assumed the major burden of organizing and preparing certain sections of the Handbook as follows:

Carl E. Allen	{ Material Purchases Material Costs and Inventories
Sterling K. Atkinson	Statistical and Mathematical Methods
Willard C. Beatty	Research and Development Costs
Victor Z. Brink	Trade Associations and Uniform Systems
Robert Bruce	Timekeeping and Payrolls
N. Madison Cantmell	The Cost Department
Gould L. Harris	Labor Costs
Donald D. Kennedy	Overhead and Product Cost
Jeremiah Lockwood	Organizing the Cost Records
Raymond P. Marple	{ Cost Classifications Budgets
Walter B. McFarland	{ Setting Standard Costs Operation of Standard Costs
Ronald H. Robnett	Reports, Analysis and Control
William S. Schlauch	Statistical and Mathematical Methods
Clarence L. Van Sickle	{ Overhead Accumulation Overhead Distribution
William J. Vatter	Estimated Costs

Special thanks are due to the National Association of Cost Accountants for permission to make extensive use of its published material and to many publishers for the use of copyrighted material. It is impossible to enumerate all the organizations that have actively aided in the preparation of this work. Acknowledgments have been made wherever possible. To the makers of accounting machines also thanks are due for their contributions in the form of literature, diagrams, forms, and information in connection with their particular machines. Finally personal thanks are herewith tendered to Stanley W. Mase, Edward G. Suffern, and Rosemarie Neumann for their help in assembling the material for some of the sections.

This seems a fitting place to pay a final tribute to the late Dr. L. P. Alford, whose Cost and Production Handbook provided a groundwork for this volume, and whose guidance in the planning of the basic outline of the present Handbook was terminated by his untimely death. The editor owes much to the qualities of wisdom, experience, and organizing genius that were Alford's.

Throughout the preparation of this Handbook, constant effort has been made to present faithfully the opinions of the many writers and reviewers who contribute to a work of this magnitude. But the final responsibility for content, arrangement, form, and emphasis rests upon the editor.

THEODOR LANG

New York City



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**COST ACCOUNTANTS'  
HANDBOOK**



## SECTION 1

### REPORTS, ANALYSIS AND CONTROL

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## SECTION 1

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### REPORTS, ANALYSIS AND CONTROL

#### Organizing Report Content

##### OBJECTIVES OF COST AND OPERATING REPORTS—

The best obtainable picture of the working practice and accomplishment of a manufacturing concern is given in well-designed cost and operating reports. They show up immediately the essential facts in such a way that those responsible can know just where to put forth efforts to bring improvement, increase effectiveness, and reduce costs. Practice differs under varying conditions so that a particular kind of report may take various forms. However, the major objectives, or desirable goals, are common to all reports.

- 1 To furnish the maximum amount of information from both operating and cost angles
- 2 To present in the most practical way the facts that reveal actual working conditions and situations to facilitate effective supervision of plant operation and to aid in attainment of high standards of efficiency and therefore realization of maximum net profit
- 3 To aid in determining policies

**Value of Cost Reports—**Intelligent use of cost and operating reports in a business makes it possible to

- 1 Plan operation systematically in advance
- 2 Obtain efficient operation
- 3 Reduce to a minimum spoilage, waste and loss
- 4 Realize final results of operation as planned
- 5 Improve processes, methods, and procedure
- 6 Conserve resources
- 7 Secure low costs
- 8 Secure rapid turnover of working capital

Funklin (Cost Reports for Executives) summed up the value of cost reports in this statement:

Cost accounting must present to the executive the full complete costs of his units of production; it must tell the story of the use and waste of his materials; it must illustrate in operation and in groups the productivity of his labor; it must picture values and returns in units and by divisions of his expenses and their relations to labor, operations and sales; it must marshal facts illustrative of the movements and relations of production and sales and of changing situation as may be deemed; or of the comparative values of methods; and it must do these things with the minimum of time and exertion on the part of the executive. For too much cost system, too many figures defeat the real purpose of cost accounting.

The use of **daily records** of performance of each workman is now recognized as standard practice in progressive plants. Such records have a direct effect upon the men in stimulating output. They also keep the foreman and production superintendent informed and furnish a base for directing productive effort into proper channels.

**ADAPTING REPORTS TO EXECUTIVE NEEDS**—The cost department must provide different types of reports fitted to the needs of executives in various positions requiring different information. It must know who the user of the report is to be, and what needs he has in order to render the most helpful type of service in the complete and accurate presentation of information required.

The importance of fitting reports to the organization is stressed by Dawes (N. A. C. A. Bulletin, vol. 22) in these words:

Accounting and particularly cost accounting will reach its greatest development and have its fullest value in those companies whose accounting executives in fact whose full accounting organization realize and practice the principle of Accounts for Operators instead of Accounts for Accountants. While there are certain basic principles of bookkeeping and auditing that must be followed and cannot be sacrificed to the whims of operating men nevertheless the accounting system and particularly the cost accounting system should be designed primarily for the use of the operators of the business and not the cost department. Any cost system that is imposed upon the operations by the cost department instead of being developed from the operations is bound to fail of its purpose and probably will instill in the minds of the operating men an aversion for and prejudice toward cost accounting that will be more injurious. It will be seen from this therefore that if the cost accounting system is to fit the operations the reports resulting from the system must not only fit but also reflect the operations clearly and accurately. It is very important therefore in the installation of a cost system to have in mind the type of reports that will be most useful to the operators and then to work back from those reports to the installation of cost methods that will produce them.

**CLASSES OF EXECUTIVES**—In developing the usefulness of cost and operating reports, three classes of executives and their needs must be recognized:

1. Minor executives including foremen, section chiefs, gang bosses, master mechanics, chief storekeeper, chief clerk, etc. These are sometimes referred to as junior executives and usually represent department heads.
2. Intermediate executives including factory superintendent, auditor, works accountant, purchasing agent, etc. Under this heading are included those executives whose scope of activity extends over more than one department, e.g., executives located in the factory office or offices, also executives who while nominally department heads are concerned with problems of coordination affecting the entire business in all its branches.
3. General executives including corporate officers and those commonly associated with the general sales and administrative functions. These include the general manager, sales manager, controller, etc.

These groups differ in the ways in which their influence is exerted and in their needs for information. There is no precise line of demarcation from one class to the next. Thus Tuttle (The Presentation of Costs for Executives), while pointing out that different types of executives are

distinguished by differences in points of view and mental processes mentions only two types

The shop foreman is so closely in contact with his men and the multitudinous difficulties that are arising every hour that he must be ready to make decisions rapidly on all manner of questions. The information to be supplied to him therefore should be related to matters with which he comes into contact daily and for which he feels responsibility and over which he exerts direct influence. The general executive of a plant is in need rather of reports which show the effectiveness of his lieutenants at various points in the plant. His function is to point out to the individuals in charge of various operations their points of failure and to inspire them to better achievement but it should not be necessary for him in most cases to point out the specific method of improvement.

**Reports for Minor Executives**—Since minor executives are concerned with details of everyday operations reports submitted to them should be detailed in character and should emphasize cost control. These men are in close contact with expenditures for labor, material, and overhead. They are concerned primarily with supervision of their departments in such a way that internal operations are both efficient and well coordinated with other departments. They cannot follow all details of the work task by task and day by day but must rely upon the foremen for the first of these objectives. Hence the reports they receive must help them to control the activities of foremen. For aid in synchronizing their activities with the rest of the business departmental budgets and reports of performance under such budgets are required. The scope of these reports is necessarily limited for the range of the users' authority is likewise narrow. However, within this range the executive is entitled to as complete a report and as good a grade of service from the cost department as the higher official.

**Reports for Intermediate Executives**—In this group are the heads of specialized staff departments such as engineering research and sales analysis. These need in addition to reports which aid them in the efficient management of their departments, special reports of many kinds to provide information for planning future policies of the business. As illustrations the engineering department might require periodic reports on power plant operation costs to aid in specifying conditions that should be maintained in the power plant, and the research department might wish to know the probable cost of using certain plant facilities to manufacture a new product which is under consideration.

**Reports for General Executives**—General executives include those who have supervision over and responsibility for functions exercised on a plant-wide scale. These men exert their influence on costs and operating results through organization, direction, and inspiration of their subordinates.

Reports for general executives are, of necessity, broadest in scope and as full as practicable concisely summarized or condensed. These individuals must adapt the organization to outside conditions and hence must know both what external forces are at work and how to control activities of their own company.

**COST REPORTS AND STANDARDS**—By comparing actual with standard costs variances are obtained which must be analyzed in reports as to causes. The success of a standard cost system is largely dependent

on the interpretation of operating results as reported on periodic statements. These should be designed to reveal variations in cost and as far as possible to state the reasons for them. If the variation is due to volume it should be apparent on the report. If it is due to excessive labor costs, that should be clear. Facts of this type are the essence of standard costs.

The modern trend in cost reports is in the direction of greater use of quantity engineering data as opposed to dollar cost figures. This is because standard costs are based on physical standards, and hence reports are prepared more quickly by letting the physical standards speak for themselves rather than translating them into standard costs. The tendency has gone so far that many variable expense budgets are prepared in terms of men and man hours rather than in terms of dollars. In this way closer cooperation between the cost and the operating departments is obtained and a greater recognition results on the part of the cost department of the problems faced by the operating department.

**REPORT PREPARATION**—Preparation of reports, whether on time or special, is a matter calling for careful planning and assignment of responsibility concerning (1) the sources from which report material is to be obtained and (2) the persons who are to compile the reports.

**Function of Cost Department**—The cost department functions as an impartial fact-collecting agency which compiles data and presents them to executives of every rank in a form most serviceable to them. However, in order to accomplish this work it has been necessary to reorganize older methods of keeping accounts in order to make ledgers yield data necessary for these new reports.

If standard costs are to be used, it is necessary not only to set up machinery for accumulating actual costs but also to establish standards by which operations of the plant are to be measured. To do this job completely budgets for all departments must be developed and a thorough study of direct costs or production made. A standard cost plan requires cooperation of the production man and the cost accountant for the cost accountant working alone is in a poor position to determine accurately the material and labor requirements of a product.

**RESPONSIBILITY OF COST ACCOUNTANT**—Instead of merely collecting cost figures a purely clerical task, the cost accountant is required to digest the significance of facts compiled and then to arrange them in a way which best enables the executive to take whatever action the situation demands. When on the other hand, cost accounting is limited to cost collecting, the executive himself must work through all the details and perform for himself the labor of summarizing and selecting the significant material from that which is irrelevant or inconsequential. This work should not be the duty of a major executive whose principal usefulness to the organization lies in serving as a leader and in getting action where it is needed.

**REQUISITES OF COST REPORTS**—Differences in operating conditions and requirements of executives yield a variety of reports differing in plan, arrangement, and purpose. There is not and cannot be, anything like a standardized practice. The necessity for satisfying the special needs of a particular executive precludes use of strictly standardized forms.



Reports should answer questions and lead to action. This requires that management be alive to the need for progress. In other words, the value of reports rests on the presence of a lively imagination and curiosity backed by a willingness and ability to take action on the basis of facts presented. In general, the rules to be observed in the preparation and presentation of reports fall into four groups:

- 1 Economy of time and effort
- 2 Physical make-up—the question of form
- 3 Time of presentation
- 4 Content

**Economy of Time and Effort**—An important consideration is that reports be constructed in such a manner that the executive may keep himself informed concerning costs with a minimum expenditure of time and effort. As Gardner (Factory Management and Maintenance, vol 9a) has put it:

Most heads of organizations are alike in one respect. They are constantly harassed and disturbed by the mass of details that they must pick apart to procure the meat of everyday happenings. The wide awake man *also* today hungers for more vivid information and less detail.

In achieving this objective, the guiding principle is “one of working *toward* the details rather than *through* them.” This means that the executive should be presented first with a summary which by itself gives him a bird’s-eye view of conditions. The principle of exceptions may be utilized in the construction of this summary, thus eliminating items which are in line with standards, for these do not require further study or action.

**Physical Make-Up**—A report well prepared and presented makes the task of the reader easier and creates a psychological reaction favorable to the author of the report. In general the following rules as to physical make-up should be observed:

- 1 Title should be fully descriptive of the nature of the report. Brevity is desirable but should not be obtained at the expense of clarity. If necessary subtitles should be used. Titles serve to identify and to convey a message.
- 2 Period covered must be clearly indicated.
- 3 Form should be simple and adjusted to understanding of persons for whom intended. Advanced statistical techniques should be used only where the reader clearly understands their implications and assumptions. For example logarithmic or semilogarithmic charts should not be employed unless the persons for whom the report is intended fully understand their use.
- 4 Columnar headings and legends should be clear and concise.
- 5 Whenever possible reports should be made visual that is be prepared in the form of charts, graphs, diagrams, etc. Graphic presentation is often the most effective device for driving home significant points of a report. (See Section 25.)
- 6 Data should be arranged in a manner which best facilitates reading and a quick grasp of their significance.
- 7 Present the summary findings first. Details supporting the summary should be available.

The executive wants to know more about items which are out of line with standards, and he should be able to follow these as far as he wishes. Supporting schedules for this purpose may accompany a summary sup-

plementary reports may be prepared or reports to subordinate executives may be gathered to aid in tracing a specific item to its source

**Time of Presentation**—Timeliness of reports is an important characteristic of successful control systems. Production executives need information that makes possible correction of conditions while the work is being performed. Executives who have cooperated in setting standards for which they are to be held accountable must have prompt and accurate reports of their actual performance.

Some companies provide foremen with comparisons of performance by the following day. According to Haskins and Gilmore (N.A.C.A. Bulletin, vol. 21) a certain textile plant presents detailed reports weekly of controllable expenses to foremen, superintendents, controller and president. Other companies get successful results with monthly reports for operating men because the foremen are so familiar with standards as to be able to exercise effective daily control with a minimum of current information.

A study reported by Robnett (N.A.C.A. Bulletin vol. 21) disclosed the importance of timing to the executive attitude toward reports.

Form, timing and executive attitude toward budget reports are in many respects the keynote of effective expense control under the budget. Elaborate plans may be developed for budgeting and the personnel may be sold on the advantages but little value will come from the plan unless the proper follow-through is present. If a foreman is sincerely interested in beating the budget but does not get accurate information on "how he is doing" until it is too late to reverse unfavorable trends he will soon lose interest in the budget as an aid to the performance of his job. This does not mean that all items should be reported weekly. It does mean that reports should be prepared promptly for the shortest possible significant period.

The timing of cost reports cannot be discussed in detail apart from the circumstances of a particular concern, for the specific problems always dictate the needs for information. The following rules governing the time element of a report should be observed:

1. Whether reports are monthly, weekly or daily they must cover a period adapted to the needs of the particular executive who is to receive them.
2. Reports must be prompt, accurate and up to date.
3. Routine reports must be submitted at regular intervals. In extreme cases, particularly where valuable materials are employed and the danger of spoilage is great, daily reports have been found insufficient. In such cases reports twice daily are instituted so that if any unfavorable tendency develops it can be caught and corrected before too much damage is done.

The rule for submission at regular intervals does not apply to special studies and analyses. These are prepared once and not repeated. Included in this group are many of the selling price studies, and studies of the cost phases of policy proposals.

**Content**—Experience has shown that effective report presentation is an art in which greatest results are secured by the observance of a few simple rules. In general, report content should:

1. Confine itself to significant facts. Emphasis should be placed upon those cost items which are most important. The cost element whose

control is important to the success of the business is naturally the one that executives want to follow most closely. For example, labor is the largest element of controllable cost in coal mining, whereas in the flour milling or brewing industries material usage and product quality must be stressed.

- 2 Be in form of comparisons where possible but the data must be comparable. Comparisons should be fairly drawn and should give recognition to essential differences with causes therefor.
- 3 Be comparable with preceding reports of same kind.
- 4 Indicate variations in cost and operating results.
- 5 Indicate where efforts should be put forth to effect improvement in operation and reduction in costs.
- 6 Be presented in such a way that responsibility for results indicated therein can be placed immediately and without question.

In general, this means that those items which are controllable by a given executive need be emphasized in the report he receives. Without question he needs to know how he stands with respect to standards for whose maintenance he is responsible and the report should show this clearly. There is no objection to placing in a report information about noncontrollable costs, in fact, to do so may aid executives to acquire a broader understanding of the company's problems. But there must be a strict separation between controllable and noncontrollable items in order that expense control may be positive and strong. The mere knowledge that responsibility for variances can be unerringly placed is a powerful incentive to keep operations and other costs in line with standards.

## Cost Analysis and Cost Control

**COST ANALYSIS DEFINED**—Cost analysis for managerial control purposes may be defined as the comparison of actual with anticipated or predetermined costs, to determine what variations have occurred, their extent and causes, to discover conditions underlying each cause and to develop or revise policies, plans, methods and practices for the purpose of eliminating unfavorable conditions and to apply these procedures to situations requiring improvement.

Another type of analysis consists of breaking up accounts and figures into their component elements. This type of analysis is often useful in furnishing detailed statistical information, but unless the latter can be matched against a yardstick of predetermined costs it is not suitable for control purposes.

Cost analysis is also used at times to denote the process of cost accumulation in the absence of a cost system. This, however, is more properly referred to as cost finding (see Section 11).

The purpose of analysis is to obtain control over costs. This is done by discovering and correcting defects in methods, physical facilities, man power, and organization. Cost analysis touches upon and affects the work of everyone in the industrial establishment. Thus its possibilities as a working tool should be clearly understood, and its procedures continually employed in attempting to secure lower costs, and in upgrading and improving operating performance.

**COST CONTROL DEFINED**—Cost control is defined by Jackson (N. A. C. A. Year Book, 1938) as

the guidance and regulation of the internal operations of a business by means of modern methods of costing through the measuring of manufacturing and sales performance

The definition emphasizes the fact that control is a matter of executive action for such control to be effective, the executive acts on information obtained by a process of analysis. Hence analysis and control represent a cause and effect relationship.

**ORGANIZATION FOR COST ANALYSIS**—In most plants the primary responsibility for cost analysis rests upon the cost department. However, often it is the function of a specific individual or group (such as a methods department) to undertake special investigations and to report any conditions where routine reports have indicated that something is wrong. Special problems may also be assigned to this group, particularly those that affect not merely one department but recur through the plant as a whole and can therefore be better dealt with on an over-all basis.

In one automobile concern such a unit, known as methods and results division, is a staff organization reporting to the vice-president in charge of production. In an electrical supply company, it is named cost reduction department and functions under the engineer of manufacture. In many concerns where operations are under control of an operating manager, and production control, time study, rate setting, materials handling, stockkeeping are under control of a production manager, the cost analysis work is under the latter.

**RESPONSIBILITIES OF OPERATING MEN**—The results of operations must be expressed as human responsibilities, not as abstract concepts. It is men who control, not figure analyses. Workers, foremen, superintendents and chief operating executives produce goods and spend money. They are the men with ability to select the most efficient manufacturing methods, to use time most productively to make the best use of material, to coordinate and integrate the enterprise in the most effective manner. To do their jobs well they need facts. Supplying the factual basis for control is a function of accounting.

It is essential that account groups be planned so that results by responsibilities flow directly from them. Nothing is more harmful to good control than confusion as to responsibility. Full cooperation between operating executives and accountants is essential in developing a proper balance between the accounting mechanisms and the control objectives. Jackson summarizes these points (N.A.C.A. Year Book 1938):

This responsibility for the control of costs must be specific and definite rather than general and unallocated. Furthermore, full cost control cannot be exercised through the accounts alone but must be based upon cooperation between the cost accountant and the operating man. It is fundamental accordingly that the cost accountant and the operating man work in close cooperation if responsibility for cost control is to be definitely allocated and maintained. Efficient cost control necessitates the placing of definite responsibility together with the granting of sufficient authority to carry out such responsibility and the full and complete accomplishment of both is dependent upon the cooperation, understanding and harmony of the cost accountant and the operating man. Thus do responsibility and cooperation become the life blood of cost control.

**Minor Executives**—Not only chief executives but their subordinates are concerned with activities that result in spending. While the principal executives determine the general plan of operations, department heads and shop foremen really determine material and labor usages. Hence, if major executives find cost data useful, minor executives should also be able to make effective use of cost information in controlling such expenses as fall within their scope of authority. The plan of furnishing cost details to minor executives has the following advantages:

- 1 It is desirable to have details of costs studied by men who are also close to details of operations. Foremen are in such a position whereas major executives lack both familiarity with details and time to study the large number of figures.
- 2 It provides a good way to develop junior executives and to relieve higher executives of burdensome detail.
- 3 It has high educational value in training minor executives to become cost conscious.

This point is emphasized by Martin (NACA Bulletin, vol 20)

**Active interest** is an intangible and elusive but extremely important factor in the control of extra costs. We do best those things in which we are interested. Therefore it behooves management to stimulate interest in the entire organization toward meeting planned labor costs. The entire organization, including the operator on the bench or machine, should be made to appreciate the following facts:

- 1 That there is a bogey (i.e. budget) of cost.
- 2 That the bogey should be met.
- 3 That to meet the bogey control must be in advance of expenditure, not a review after the money is spent.
- 4 That preventive measures of control are more effective than corrective measures.
- 5 That if corrective measures are necessary they must be taken immediately in order to minimize the extra cost.

The principal objection offered against the above plan is that costs should not be divulged except to those who can be trusted to maintain their secrecy, in order to avoid having valuable information fall into the hands of persons who would use it to the detriment of the organization. This can however be largely avoided by limiting the scope of cost data received by a specific employee to matters that lie within his authority to control. Thus a statement of how a certain foreman's performance compares with standard is of little value to outsiders because the statement covers only a limited field of operations which probably is not comparable with conditions to be found in any other organization. Without the noncontrollable overhead, no estimate of the real unit cost of the product can be made, and even the material cost means little when it is not known whether in-freight, purchasing expense, receiving expense, etc., have been included or how the standards were set.

**Chief Executives**—While quite ready to accept standards and use variance reports as long as these things apply to subordinates, general executives do not always welcome application of the same methods to expenses for which they are directly responsible. It is however, important that these costs also be included within the budgetary program for major executives not only spend money for maintenance of a personal staff (although this may be a relatively small item), but they exercise

control over large capital outlays which are responsible for much of the fixed burden that must be carried by the business. These costs need to be set up in a long-run capital expenditure budget and results checked against anticipations to measure the soundness of executive judgment. Such a practice may bring home the importance of careful study in such matters by showing executives the results of their decisions. (See Section 23 on Budgets.)

**Controller**—The current trend is to make the controller coordinate in rank with executives in charge of production, sales, and finance. He usually reports to the chief executive, and in some cases directly to the board of directors. As chief accounting officer, the controller is responsible for all ramifications of the accounting function. Knapp and Beysbold (*Managing for Profit*) define controllership as

The coordinating function in a business, working in a detached and unbiased way and charged with the responsibility of planning for profits and providing suitable control machinery. It is the investigative, analytical, suggestive and advisory function studying the business at all points all the time and formulating what the proposed practice should be with reference to sales, production and financial control which when accepted or modified by the executive becomes the approved practice for use by the performance or line function of the business.

(For discussion of duties of controller, see Section 4, The Cost Department.)

**Accountants**—The accounting division performs a valuable service in assisting management and operating men in setting standards for performance, in devising procedures for presenting objectives in clear and understandable form and in compiling results of actual performance in a way which facilitates prompt control action. It is the accountant's duty to present facts in a constructive unbiased manner and to interpret them where advisable. Thus, those men responsible for performance are supplied with information which accurately informs them of conditions and enables them to take direct constructive action in terms of human responsibilities.

The essence of successful control of costs and expenses is the clear defining of organizational responsibilities, hence the accountant must have a good understanding of the operating functions of the business. He must know enough of production distribution, and financial operations of the company to assist constructively in planning operations, to report accurately, and to interpret results in an unbiased and effective manner.

Fiske comments on this point as follows (*World Power Conference 1936 vol 4*)

The function of costs (and of statistics) is merely to provide the executives with that cost and operating information upon which intelligent control must inevitably be based. The controller or accounting department must anticipate the needs of every executive if the necessary facts are to be accumulated and available when wanted. He (the accountant) should be so trained as to appreciate the functions and broad problems of the other divisions and he must be sufficiently intelligent to go to the other executives to discuss with them and learn from them what particular facts will be required and at what intervals. To those executives he should be able to offer the benefits of his experience as to types of analysis required.

**HOW COST CONTROL IS MAINTAINED**—There are four essential steps in establishing and maintaining control over costs, as formulated by Stevenson Jordan & Harrison, Inc (Making Profit Plans Come True)

- 1 A clear definition of the objective This involves a predetermination of what the results should be and what it should cost to secure them In other words reliable engineering standards and cost standards must be set
- 2 A measurement of actual accomplishment in comparison with the plan This necessitates establishment of a continuous and up to date comparison of actual costs with standard costs in order to develop variances from standards
- 3 Investigation to determine the causes of failure to perform according to plan This calls for interpretation of variances to determine whether or not they are significant and why they have occurred
- 4 Institution of corrective action where needed to bring substandard performance into line with standards This may also call for a revision of the original plan where necessary to compensate for changing conditions

These have been further elaborated by Raymond P. Maiple of the National Association of Cost Accountants, who has prepared the following outline of cost control principles

- 1 Accounts should be fitted to organization chart so that costs can be segregated by individual responsibilities
- 2 Cost accounts by individual responsibilities should be subdivided under uniform classifications to show nature of expenditures
- 3 Goals in the form of standards, budgets, and allowances should be set and constantly kept up to date
- 4 Where justifiable cost varies with the rate of activity variable or flexible budgets and allowances should be developed
- 5 Standards, budgets, and allowances should be prepared with the cooperation of the person responsible for each cost item and should be agreed to by him
- 6 Variations of actual costs from standard or budget should be segregated and shown in sufficient detail so that responsibility for each variance can be definitely determined
- 7 Frequent reports of the costs for which he is responsible should be supplied each person who is responsible for control of any cost element These reports should emphasize variances of actual costs from standards or budgeted figures
- 8 Apportioned or prorated costs over which an executive or subexecutive has no control should not be combined in his cost reports with the costs over which he does have control
- 9 As an inducement to those responsible for the control of costs an incentive system of the "savings sharing" sort should be developed

### Control Through Standards

**IMPORTANCE OF ADEQUATE STANDARDS**—Costs can be justified only in terms of what they ought to be under the particular operating conditions Thus, Fiske (World Power Conference 1936 vol 4) states

The need for standards is implied in the word control itself There must be conscious or subconscious standards or limits if expenses are to be

"controlled" The very statement that expenses or costs are "out of line" or "too high" connotes a line or level from which expenses or costs have departed.

Standards are used by all businesses for expense control. The control can only be as effective as the soundness of the standard used is a basis for measurement.

Study of the setting of standards in addition to the value of its results in expense control usually pays big dividends in discovery of ways of reducing expenses.

The setting of sound standards is an engineering job and the success of the control plan stands or falls on the contribution of engineers for quantity standards are its very foundation. Material requirements waste and spoilage allowances yields operation and process time standards and power and other service requirements are all engineering jobs. It is these quantities which are subject to control. Costs are the product of quantities and prices but prices are generally an uncontrollable item leaving quantities as the only factor subject to control. Indeed reports in terms of quantities (quantities of materials used or waste or spoilage of power etc) will frequently form the backbone of the control plan. If production executives can keep these within standard tolerances, then costs will take care of themselves.

**RELATION BETWEEN STANDARD QUANTITIES AND STANDARD COSTS**—Sound quantity standards are the foundation of any control plan. The contribution of the engineer and production man in the determination of proper allowances for labor times or material quantities is vital to the setting of proper standards for control.

A standard cost is the monetary expression of these quantity standards. With the establishment of a standard price per unit of standard time or standard quantity a quantity standard can be expressed in dollars. If a certain labor operation has a quantity standard of two hours and a price standard of \$90 per hour, the resultant standard cost is \$180. If the quantity standard for a material is 8 pounds and the price standard per pound is \$40 the standard cost is \$320.

**CONTROLLABLE AND UNCONTROLLABLE COSTS**—Product costs in a particular department include both costs incurred within the department and those prorated to it from other departments. Costs prorated from without are not controllable by the department head to whom such costs are prorated. Likewise certain costs incurred within a department are often not controllable by the foreman.

A foreman can control time spent on an operation, but he usually has no control over wage rates or changes in those rates. He can control material usage, spoilage, etc, but he cannot control the prices paid for material. At a given volume of production he can control the activities of sweepers, helpers, oilers, and cleaners and other items of indirect cost, but cannot control changes in the volume of production allocated to his department or the prices paid for each unit of such service.

A good standard cost system recognizes the distinction between controllable and uncontrollable items under a particular responsibility and thus facilitates analysis of results for effective control.

Assume a labor operation with a quantity standard of two hours and a labor price standard of \$90 per hour and a resultant standard cost of \$180. For 1000 such pieces the standard cost as charged through records is \$1800. Assume also that actual labor costs incurred were \$1950. The resulting difference as shown by the records appears to be an unfavorable



variance of \$150. Without further analysis management might interpret this difference as evidence of inefficiency on the part of the foreman. Under a standard cost system it is possible to analyze variances into quantity and price factors. Suppose that such analysis revealed that hours actually worked were 1950 and that the wage rate per hour had been changed (by management action) to \$1.00 per hour. The following analysis results:

Standard for 1 000 pieces	2 000 hours at \$ .90 per hour	\$1 800
Actual for 1 000 pieces	1 950 hours at \$1.00 per hour	1 950
Total variance to be accounted for		<u>\$ -150</u>

Accounted for as follows:

1 Rate variance	$1\,950 \times \$10 = -\$105$
2 Time (efficiency) variance	$50 \text{ hrs} \times \$30 = +45$
	<u>-\$ 150</u>

By this approach, attention is focused on causes of variance, thus fulfilling one of the essentials of any control mechanism. (See Sections 2 and 7 for detailed discussion of variances.)

#### LIMITATIONS OF STANDARD COSTS FOR CONTROL—

The most common difficulty in interpreting variations results from fluctuations in the volume of production. Product standard costs are expressed as costs per unit of product. These in turn are made up of unit standard costs of performing each operation, unit standard costs of materials, and unit standard costs of overhead in each department. Overhead standard costs per unit must be based upon an assumption as to volume of production.

Many types of overhead items do not vary proportionately with changes in volume. With unit standard costs however, the same amount of overhead per unit of product goes through the records regardless of the volume of production. Because actual fixed or semi-fixed expenses are charged to the records as incurred, the result is "overabsorbed" burden if volume is high or "underabsorbed" burden if volume is low. Nearly every business has both seasonal and cyclical variations from a "normal" volume. It is almost inevitable that every operating period is at variance in some degree from the volume level upon which unit overhead standard costs are based.

The decision as to the volume of work to be performed in a department in a particular operating period is not made by the foreman but elsewhere. Under such conditions a control report measuring efficiency of a foreman can be prepared only after the volume variance is identified, analyzed, and segregated from the figures presented as a measure of the foreman's effectiveness in discharging his responsibility. Analyses of noncontrollable variances (of which price and volume variances are the principal types) must be made before such controllable items as material usage and labor efficiency can be identified and reported to those responsible for them.

**PRINCIPLE OF EXCEPTIONS**—Once plans have been prepared, the executive is less concerned with performance which is in accord with the budget than with those matters that deviate from it. Therefore it is the latter class of occurrences only that need be brought to the executive's attention. Operations which are progressing satisfactorily can safely be left to persons charged with doing routine work in order that the time of executives may be devoted to planning and ad-

centain by the analytical process that the decrease is a legitimate one and has not been more than offset by a corresponding increase somewhere. Introduction of a substitute material may result in a decrease in direct material costs but it may also result in increased labor, tool, spoilage or other cost. Sometimes the substitution of labor, the quality of product, and the subsequent performance of machines and tools are affected as a result of efforts to reduce cost of materials or supplies. These conditions do not immediately show up in the manufacturing costs but are nonetheless real, though difficult to find and measure.

**MATERIAL PRICE VARIANCES**—It is always desirable that price variances be segregated from operating variances so that each one may be given its proper place and executives be held responsible only for those within their control. The analysis of price variances is simplified by performing such analysis at the time of vouchering. Thus Sanders (*Cost Accounting for Control*) states:

Some companies analyze invoices as soon as they are received into standard costs and variations therefrom; the standard costs are entered immediately in the records and afterwards carried to the manufacturing accounts. In this way the purchase variations are picked up immediately and shown in the reports to the executives.

**Price Variance Reports**—Fig. 1 is a report of material price variations suggested by Perry (*N.A.C.A. Year Book 1941*). Its purpose is to separate the price variance factor from the usage factor on both raw and manufactured materials. The usage factor is subjected to later analysis on the basis of controllable efficiencies. This report compares actual against standard in dollars at the time of purchase, including standard and actual unit prices and quantity purchased. Both the mill vice-president and purchasing agent receive the report.

**Responsibility of Purchasing Department**—Action of the purchasing department with respect to buying policies influences both price and usage of material. Price is usually thought of as uncontrollable, since it is largely an outside factor. Nevertheless, the purchasing department can control price to some extent through efforts to obtain maximum cash discounts, quantity discounts by placing orders in oft seasons, by spreading orders over a period of time by entering into contract obligations, etc. To these may also be added such circumstances as use by the manufacturing department of a type of material costing more than that called for in the specifications, because the purchasing department failed to maintain an adequate supply of the needed variety.

Some variances, in particular those of market price, result from changes in external circumstances over which the plant has little or no control. Hence these variances are not to be regarded primarily as indexes of personal performance by the purchasing officer, but instead as indicators of possible needs for changes in standards, in the product price, or in the kind of materials used.

The extent to which the **purchasing agent** is responsible for price is a matter of administrative policy. Buying on basis of price alone may degenerate into speculation. It may also tie up needed working capital in large inventory items when such capital is needed for other items. Whether a purchasing agent shall be allowed discretion to buy when

	Standard Price	Actual Price	Quantity Purchased	Total Value at Standard	Total Value at Actual	Price Variations
<b>RAW MATERIALS</b>						
Warp Yarn—						
10/2 Carded	28	248	54 136	\$15 158	\$13 447	\$1 711
20/2	31	30	10 051	3 116	3 015	101
Etc						
Spool Yarn						
20/2 Carded						
20/2						
Etc						
Bobbin Yarn						
80/2 Combed						
90/2						
Etc						
<b>MANUFACTURING MATERIALS</b>						
Boxes						
Cartons						
Cellophane						
Cord and Twine						
Dyes						
Envelopes						
Paper						
Soap						
Tape						
Thread						
Totals				\$98 747	\$90 504	\$8 243

[Detailed figures purposely omitted]

Fig 1 Material Price Variance Report

he considers conditions favorable must be decided on the merits of each case. Sanders (Cost Accounting for Control) states:

In the great majority of cases the safer policy is to have the purchasing of materials carefully related to the manufacturing needs of the business. If the purchasing agent is to speculate in raw materials as is done when he buys more than is immediately necessary, two safeguards should be put on the situation: first it should be determined by special vote of the directors, and second such excess purchases should be separately accounted for in order to show the results of the policy.

**Changes in Quality of Materials Used**—Substitution of materials may cause both price and usage variances. Such changes are brought about by substitution at the instance of

- 1 Engineering department
- 2 Purchasing department
- 3 Foreman in the operating department

The change may be wilful or it may be brought about by necessity because of the lack of the material originally specified. Such substitutions of material must be carefully watched both as to their effect on material prices and material usage. It often happens that a favorable price variance, because of cheaper materials is offset by unfavorable usage variance because the cheaper material produces more spoilage and therefore involves greater consumption. The reverse may of course be true—that is by using better material a net saving can be effected through more economical use of materials.

In a Connecticut hardware manufacturing concern a 5% increase in direct materials cost netted a 10% decrease in other costs of manufacturing a particular product. Many concerns producing two or more of a product have found that it is economy to use the same materials in both products. The Ford automobile is in many respects an illustration of this idea. Good management practice requires that each element of direct or indirect cost affected in any way by a proposed change in product, machine, or tool be carefully analyzed and the total savings or cost determined before authorization for the change is given.

**Responsibility of Engineering Department**—The action of the engineering department may also be responsible for both price and usage variances. This they can accomplish by

- 1 Authorizing the substitution of a different material than that originally specified
- 2 By changing the processing technique involving tool changes, redesigning of product, etc.

**USAGE VARIANCES**—Under this heading are included all those production factors that have a direct bearing upon the consumption of material. These range all the way from changes in design of machinery, tools, or product to the gains or losses arising from the handling or processing of the material.

**Material Usage Reports**—Fig. 2 shows a material usage variance report as used by Perry (NACA Year Book, 1941). It is prepared for the manufacturing vice-president, superintendent of weaving looms and department handling raw materials. The report shows responsibilities by looms for material usage by comparing the actual material consump-

tion with the standard cost allowance. A similar report is described by Laus (N A C A Year Book, 1935 also N A C A Bulletin, vol 19). In the latter case, usage standards are expressed in pounds for each product specification. A daily report issued by the cost department to foremen shows only those items on which the actual weights used exceed standard weights allowed. Foremen thus concentrate daily on those items in excess of standard. A weekly report (Fig 3), comparing actual and

Loom No	Standard Cost Allowance Inc Wastc	Actual Usage at Standard Prices	Usage Variation	% of Standard
1	\$ 4 006	\$ 3 993	\$ 13	99.7
2	4 137	4 308	161*	103.9
3	4 692	4 623	69	98.5
Etc				
10	3 786	3 973	187*	104.9
20	4 803	4 763	40	99.1
Totals	\$86 735	\$88 143	\$1 408*	101.6

\* Denotes red figures

FIG 2 Material Usage Variance Report

standard usage, is prepared by the cost department by product lines. It lists the complete performance in addition to allowable standards. For each model of running board the total number produced during the week is shown, total weight of material used, unit actual weight standard weight, the physical and dollar variances on each product for the week and cumulative to date. A monthly report summarizes the cost variances by products (Fig 4).

**Changes in Design of Product, Machinery, or Tools**—Development and improvement of products, machinery, and tools are necessary to plant progress, and analysis of direct material costs should stimulate and not retard this process. However, in many cases cost of direct materials is increased by changes in product, tools, or machines. Sometimes the increase is due to making stocks of materials obsolete, at others it is due to an increased consumption of materials or the use of more expensive materials. It is always necessary in case material costs have increased due to this cause to analyze other accounts which may be affected and thereby discover if there has been a compensating decrease in the costs of some other element. This is frequently the case.

**Changes in Methods of Processing or Fabricating**—A change in methods of processing or fabricating, like a change in product or machinery, may produce a greater effect on other elements of cost than it does on material cost. In fact, unless a change in method reduces the quantity of materials required, or reduces the amount of spoilage, no change in material costs will take place. It is assumed that the changed method does not bring about obsolescence of materials in stock. Time study, rate setting and methods engineers must look to production control and the cost accounting divisions for much information before introducing changes which will be economical when all costs are calculated.

COMPOUND USAGE ON WHEELS  
WEEK ENDING APRIL 3 19—

Part No	No of Wheels Prep	Std Wt Per Wheel	Total Std Lbs Per Whls Prep	Net Lbs Comp Used on Wheels	Lbs Variance from Std	Cost Variance	
						Current Week	Cumulative
500170	3 430	2 875					
750992	27 176	2 594					
731082	105	2 188					
751738	3 761	3 508					
752610	15 601	2 016					
All Wheels Using 6165 Compound			125 232	125 136	96	\$ 4 49	\$— 242 96
All Wheels Using 6286 Compound				—52	52	2 76	— 818 66
Mixed Compound Scrapped from Wheel Presses							1 81
TOTAL COST VARIANCE						\$ 7 —	\$—1 059 81

[Detailed figures purposely omitted]

Factory Accounts Department

FIG 3 Report of Material Usage

**SUMMARY OF MATERIAL USAGE COST VARIANCE FROM STANDARD**  
**FOR PERIOD FEBRUARY 28 TO APRIL 3 19—**

	Cost Variance				Total Cost Variance		Val Mat at Std 2/28-4/3	Val Mat at Std 8/19-4/3	% of Var from Std 2/28-4/3	% of Var from Std 8/19-4/3
	Wk End 3/6	Wk End 3/13	Wk End 3/20	Wk End 3/27	Wk End 4/3	Wk End 4/3				
	CONTROLLED PRODUCTS SHOWN ON SAVINGS REPORT									
Running Boards	\$ 246 02	\$ 1 043 25	\$ 837 81	\$ 572 10	\$ -2 94	\$ 701 27	\$ 11 236 36	\$ 174 126 00	1 55%	1 90%
Wheels										
C V Straps										
W S Straps										
Ice Trays and Grds										
Misc Products										
Antenna										
Wheel Paint (Black)										
Running Board Paint										
Hyd Brake Hose										
Rear Compt Strip										
Total Variance	\$ 1 020 94	\$ 1 844 14	\$ 1 210 00	\$ 1 185 12	\$ 298 50	\$ 540 0	\$ 9 540 11	\$ 193 925 00	1 319%	44%

[Detailed figures purposely omitted]

**UNCONTROLLED PRODUCTS NOT SHOWN ON SAVINGS REPORT**

Misc Products	\$ 0	\$ 0	\$ 0	\$ 0	\$ 0	\$ 0	\$ -	\$ 858 62 (A)
Wheel Paint (Brown)	-62 96	50 83	39 00	-11 66	-43 02	-27 14	-	941 77
<b>Total Variance</b>	-62 96	50 83	39 00	11 66	-43 02	-27 14	-	1 900 39
<b>GRAND TOTAL VARIANCE</b>	\$ 958 68	\$ 1 894 97	\$ 1 249 00	\$ 1 173 40	\$ 248 45	\$ 519 56	\$ 7 739 72	

NOTE (A) Cost Variance for period 8/2-8/13 before all Misc Products were shown on Savings Report

Factory Accounting Department

**FIG 4 Monthly Summary Report of Material Usage Variances (by products)**

**Excess Spoilage of Materials During Production**—Basically, spoilage is a symptom rather than a cause of cost variations. It is difficult to control because so many factors are involved any one or any combination of which may be responsible. Failure to follow specifications, or in instructions, defective materials, tools, machinery, or methods including speed and feed of machines, green operators, lack of adequate instructions, incorrect instructions, worn inspection tools, careless acts of operators, and poor wage payment plans are but a few of the production factors which may lead to spoilage. An understanding of the cause suggests underlying conditions as well as management practices necessary to eliminate or control the conditions.

**Losses in the Storesroom**—Storesrooms are sometimes more prolific as sources of material loss than manufacturing operations. This may be due to lack of good organization, poor material accounting controls, inadequate storage space, poor location of storesrooms, lack of proper stores facilities, carelessness in handling or storing materials, incorrect issue of materials, theft, or any one or more of many other causes. To eliminate losses in the storesroom it is essential that it be properly organized, personnel carefully chosen and properly trained and supervised, that methods of operation and control be efficient and adequate space, facilities, and protection furnished for materials to be stored.

**Damage in Handling**—This cause for waste of materials should be entirely eliminated except for semi-occasional and unavoidable accidents. Conditions producing the cause are lack of adequate handling devices, lack of aisles, corridors or runways for handling, and failure to train handling force. In the main determination of needed handling equipment is an engineering problem as is layout of handling space.

**Too Rigid Inspection**—Quality of product cannot be jeopardized for a possible chance to make small savings in direct materials costs. However, there are times when inspection limits are too finely drawn and excessive rejection occurs. It is oftentimes possible slightly to relax inspection limits without changing or affecting in any way standards of quality. Engineers are likely to think in terms of high precision and accuracy rather than of costs, with result that limits may be set which are unnecessarily rigid. Time study and methods men are frequently in a good position to unearth cases of too rigid inspection.

**Errors in Accounting Charges**—This cause is of a minor nature and should seldom occur. Occasionally, because of an indefinite account classification, failure of requisitioner to indicate account or production order to be charged with materials, or carelessness on the part of the material control or cost clerk, materials are charged to the wrong production order, or materials intended for experimental tool, or maintenance use may be charged to a production order. If requisitions are refused unless they indicate the charge, and due care is used by those handling requisitions in the control and cost departments, such errors can be practically eliminated.

Another error of an accounting nature occurs through failure of the production department to return unneeded material to the storesroom for credit, or failure to obtain a material credit slip when excess material is returned. In both cases material usage is distorted unfavorably. It is



the foreman's responsibility to make sure that all excess material is returned and proper credit is received.

**SUPPLIES AND OTHER INDIRECT MATERIALS**—Physical and accounting control of supplies and indirect materials is frequently less positive and less accurate than for direct materials, either because of the difficulty in measuring their consumption, or because it is not thought worth while. In many cases this is due to the belief that the cost of definite control over items of supplies and indirect material would be in excess of its value and even greater in some cases than the cost of the supplies. Waste in the storeroom, lack of protection to supplies held in an operating department, carelessness in issue and use, substitution of an expensive supply item for a cheap one that should be used, and other such causes promote waste and increase cost.

### Analysis of Labor Costs

**DIRECT LABOR VARIANCES**—In line with the managerial "principle of exceptions" analysis of direct labor cost should center around the variations from standard. Assuming the standards to be set properly, management's concern is to attain them. Excess labor cost (i.e. above standard) indicates the existence of conditions which call for correction. The cause of such excesses must be analyzed and, if possible, removed.

Comparison of actual labor cost per unit for one period with that of another period, or with the standard labor cost per unit, is only the starting point in labor cost analysis. It measures total variation or excess but discloses no information concerning causes. Since labor cost is a function of two factors, wage rate and time, it follows that the excess must be quantitatively broken down in terms of these factors.

The analysis of direct labor cost variances follows the same general plan as that for direct material cost variances, but the causes of the variances differ. A list of possible labor variance causes follows:

- 1 Rate variance sources
  - a Wage rate changes
  - b Change of payment plan e.g. from piecework to time work, etc
  - c Change in grade of labor used
  - d Clerical errors
- 2 Time or efficiency variances as affected by
  - a Selection of workers
  - b Training of workers
  - c Frequency of change overs
  - d Labor turnover
  - e Incentive wage payment plan
  - f Working conditions
  - g Working hours
  - h Honesty among workers
  - i Selection of machines and tools
  - j Changes in design of product
  - k Changes in machinery, tools, or methods of production
  - l Adequate accounting or production records

These reasons for labor cost variances represent managerial problems. The problem of the cost analyst is to discover the reasons behind the

reasons, i.e., why workers are poorly trained improperly supervised, etc. This is a task which takes the analyst beyond the realm of cost accounting. He constitutes in effect a sort of liaison between the cost department and those executives in a plant charged with the formulation and execution of managerial policies. By interviews, questioning, conferences in general, by face to face talk, the cost analyst works back from the report figures to the underlying causes for subnormal performance. He then states his conclusions, and leaves to executive action the indicated remedy. (For methods of computing labor variances see Sections 2 and 7.)

The immediate control of direct labor cost is, in most concerns, in the hands of foremen. This requires that they be provided with reports daily or weekly to help them in keeping this element of cost within standard limits. Where the rates paid are determined by a contract with a union or by executives other than foremen, only the usage and selection of the correct grade of labor is chargeable to foremen.

Numerous devices for gaining the cooperation of both workmen and foremen have been applied to aid in keeping direct labor costs within the standards. Among the most effective of these are:

- 1 Informing the workman of the standard on each job before he begins work on it
- 2 Use of an incentive payment plan which rewards the worker for maintaining standards

**RATE VARIANCES**—Rate variances represent the difference between the standard cost for the standard time allowance and the actual cost for the same time allowance. The most obvious cause of rate variances is occasioned by authorized changes in the wage structure. In the case of increased wage rates the question that should be raised is why the increase occurred, particularly if it is not an annual increase covered by company wage policy. Even in such cases it may be worth while to review the policy. Many plants pay an excessive labor bill because they have no fixed wage payment policies and increases are result of individual bargaining or favoritism. As a matter of setting fair wage standards and granting increases upon basis of merit rather than continuous service and to avoid dissatisfaction of workers and steadily mounting costs without increases in productivity, job classifications and salary ranges for each job should be worked out. The resulting wage increases will then come only as a worker is moved from one job class to another. Unless transfers receive the constant attention of management, the plant is in no better shape than when it had no wage standardization. Other forces less obvious also produce rate variances, for example, changing the method of payment such as changing from time work to piecework or errors in the payroll department in using the wrong rates may produce seeming rate variances.

One cause of excess labor cost is to be found in the payment of above standard rates. The amount, but not the cause, of this excess is disclosed by the rate variance account. Actually there are two principal causes of a wage rate variance, aside from authorized wage increases:

- 1 Employment of high rate employees on low rate tasks
- 2 Overtime work

In the former case an increase in the average hourly rate of a department takes place, although no one has been given a wage increase. In the case of overtime a similar increase takes place due to the premium wage paid for the excess hours. The presence of both should be checked constantly through reports. Fig 5 is designed to disclose the presence of the former and at the same time to show the amount of overtime in dollars.

In this report the difference between columns (3) and (4) represents overtime in dollars. Column (6) is derived from (4) and (5) and affords a significant comparison with (2). The difference shown in column (7) indicates the presence of the first cause of labor rate variance mentioned above. This report may be supplemented by a report on overtime hours.

AVERAGE HOURLY PAYROLL							
DEPARTMENT _____				WEEK ENDING _____			
(1) JOB RATE CLASSIFICA TION	(2) MIDPOINT OF CLASS	(3) TOTAL PAYROLL INCLUDING OVERTIME	(4) TOTAL PAYROLL EXCLUDING OVERTIME	(5) TOTAL HOURS WORKED	(6) AVERAGE HOURLY EARNINGS EXCLUDING OVERTIME (4) ÷ (5)	(7) DIFFERENCE BETWEEN CLASSIFIED RATE AND AVERAGE RATE (2) - (6)	(8) REASONS
\$ 50 - 59	\$ 55						
60 - 69	65						
70 - 79	75						
TOTALS							

FIG 5 Average Hourly Payroll Analysis

**TIME VARIANCES**—The second cause of excess labor cost lies in the time factor, and concerns the use of an excessive number of labor hours to perform a given quantity of work. Not only are the reasons more numerous than those which create labor rate variances but they are also harder to discover and control. Consequently, the bulk of labor reports is devoted to the time element.

A comparison between estimated or budgeted unit man-hours and actual unit man-hours, revealing either a gain or loss, is provided for in Fig 6. Study of such a report may lead to an investigation of the effectiveness of labor and to a revision of labor policies. Tracing back to causes, there may be revealed that the right man was not placed in the right job, that a foreman has failed to secure cooperation of workers,

that training and instruction of new workers was inefficient and faulty, that wage incentive plans were lacking, or that labor turnover was excessive. Information thus presented and compared has a direct bearing upon individual productivity of workers under the forerun of a department. The report covers a week, but a similar report should be prepared daily. The latter represents standard practice in the case of one automobile manufacturer where a daily plant report includes a comparison of actual and standard labor costs.

**Selection of Workers**—Choice of a worker who is mentally or physically unfit for his job or whose personality does not harmonize with those of other men in the shops is a sure way to increase costs. Limitations of accurate mechanisms for measuring skills, mentality, attitudes

DIRECT LABOR WEEKLY GAIN AND LOSS REPORT									
FOREMAN <i>L. E. Pratt</i>			DEPARTMENT #18			WEEK ENDING <i>February 11, 19--</i>			
TYPE OR STYLE	BUDGET			ACTUAL			GAIN PER UNIT	LOSS PER UNIT	REMARKS
	Production	Unit Man Hours	Total Man Hours	Production	Unit Man Hours	Total Man Hours			

FIG. 6 Direct Labor Weekly Gain and Loss Report

etc., are recognized, yet it is possible, where careful job analyses and specifications have been made for a trained employment man to choose labor with greater accuracy than where jobs have not been analyzed or where choice is made by someone not thoroughly skilled in the work. Oftentimes it is not inherent weakness of the man selected but a combination of man and job. The psychiatrist has been of some value in helping to place men in the right jobs. Centralized employment man-job specifications, preemployment medical examinations, and no "job selling" during the employment process are helpful.

**Training of Workers**—It is not always profitable to seek the trained man. It may be easier and cheaper to do original training. Oftentimes a worker receives job training from someone who is not interested, does not know correct methods, or fails to impart full instruction. Too frequently as a matter of economy the new man receives his instruction from a fellow workman who knows but little more than he, or who is not paid for this time-taking work. It is not always easy to determine what training is needed and the best way to give it, but needs for training must be as clearly defined as possible, and methods selected which produce most efficient and economical results. Close cooperation between planning or methods work and training department is essential.

It is possible to analyze the effect on efficiency of the breaking in of new employees, particularly in those cases where the new employee is not trained by a separate training division but takes his place immediately in the shop and is trained by a regular operator. Where the new

employee is a substitution and not an addition to the force there results a two way drop in efficiency that brought about by substitution of a green operator for an experienced operator and loss of output of the operator charged with the new comer's instruction. The following example illustrates the importance of this problem.

**ACTUAL PRODUCTION IN UNITS**  
(Normal output per day = 100 units)

Day	Output for New Employee (in units)	Output for Experienced Employee (charged with training) (in units)	Total Units
1	10	20	30
2	15	30	45
3	25	50	75
4	40	80	120
5	45	100	145
6	60	100	160
7	75	100	175
8	90	100	190
9	96	100	196
10	100	100	200
Totals	556	780	1336

Aggregate efficiency for the "team" during the 10 day training period is measured by the ratio  $\frac{1336}{2,000} = 66.8\%$ . This does not mean that unit labor costs rise proportionately, since the new employee may not be paid the standard rate while learning. In the case of the experienced worker however, there is a direct relationship between his loss of efficiency and unit cost.

**Frequency of Change-Overs**—An important cause of excess direct labor costs is frequent change-over on jobs. If a given production department processes a "family" of types which are sufficiently dissimilar to require some change in procedure, there is bound to follow upon each change-over a lowering of efficiency and if change overs are frequent, the loss may be significant. To measure the loss there must be data on

- 1 Number of change overs
- 2 Length of runs
- 3 Daily output per operator

The method of analysis is illustrated below. In this case a given department processes four related products A, B, C, and D. For each type a normal weekly output per operator has been established. Study of performance records indicates a drop in output when a new type is put in process, and time required to recover to normal efficiency, as follows:

	Type A	Type B	Type C	Type D
Standard output per operator per week—units	200	150	100	500
Output upon change over—units	100	50	20	100
Time to recover to standard output—weeks	2	2	1	3

In calculating **average relative efficiency** throughout the recovery period it is feasible for short periods to assume straight-line recovery. In case of a change to type A for example production falls to a rate of 100 units per week. By the end of the first week the rate has risen to 150 units the average for the week being 125. The production rate for second week begins at 150 and ends at 200 the average being 175. The average for the two weeks is 150 or 75% of normal. On the same basis changes to other types result in the following average rates of efficiency during the recovery period, B 66⅔%, C, 60% D 60%.

It is apparent that frequent change-overs may result in serious loss of **operating efficiency**. The loss obviously is reduced as the length of run is increased, and increased with shorter runs. The example given below illustrates this fact and is based on the foregoing data with additional information covering length of runs.

No of Run	Type	Weeks to Recovery	Length of Run (in weeks)	Average Efficiency %
1	A	2	2	75.0
2	B	2	2	77.8
3	C	1	2	80.0
4	D	3	2	46.7
5	A	2	3	83.3

**First run.** Since actual run is for normal recovery period average efficiency is 75%.

**Second run.** Output in units for each of three weeks would be respectively 75, 125 and 150 and average for three weeks is a whole would be 116⅔ or 77.8% of standard.

**Third run.** Output in units for each of two weeks is 60 and 100 and average for period is 80 or 80% of standard.

**Fourth run.** Output for each of two weeks is respectively 100 and 300 units and average for run is 233⅓ units or 46.7% of standard.

**Fifth run.** Output for each of three weeks is respectively 125, 175 and 200 and average for run is 166⅔ or 83⅓% of standard. Note that with two week run for type A, average efficiency is 75% with three week run average is 83⅓%.

The full effect of these frequent change-overs on operating efficiency for the twelve-week period is indicated by the following summary.

No of Run	Type	Length of Run (in weeks)	Standard Output for Run (in units)	Actual Output for Run (in units)
1	A	2	400	300
2	B	3	150	350*
3	C	2	200	160
4	D	2	1 000	467*
5	A	3	600	500
Totals		12	2 600	1 777
Percent of standard				67.96

\* Approximate

The effect of short runs and frequent change-overs is so marked as to call for careful study of a company's production policy. Use of a **Gantt type chart** is very useful in focusing attention on this problem.

The illustration presented above omits certain factors which in practice must be considered

- 1 No allowance has been made for set up time. This varies considerably depending upon the nature of the change and may result in a much sharper drop in efficiency than that illustrated.
- 2 No mention was made of costs of the alternative policy of longer runs and fewer change overs. Whether this policy can be adopted depends on the ability of the management to forecast sales accurately and on the availability of storage facilities and costs thereof.

**Labor Turnover**—Loss of efficiency resulting from changes in the working force is of such significance as to call for periodic reports on labor turnover. Fig 7 is an illustration of such a report, adapted from Dohr, Ingham, and Love (Cost Accounting).

### LABOR TURNOVER REPORT

PERIOD ENDING \_\_\_\_\_

	Dept 1	Dept 2	Dept 3	Dept 4
Number employed at beginning	48	53	100	11
Added during period	8	10	15	2
Total	56	63	115	13
Number of separations during period	11	7	20	8
Number employed at end	45	56	95	10
Turnover index*	204	156	150	33
Turnover previous period	196	161	135	210

\* Calculated for Department 4  $\frac{2+3}{2} - \frac{11+10}{9} = 238$

FIG 7 Labor Turnover Report

**Incentive Wage Payment Plan**—Reitell advocates the payment of specific percentages of savings achieved through beating standards to those responsible for the success accomplished. In this way each supervisor's bonus is closely allied with the work and the expenses under his direct control and with the savings his control accomplishes.

The incentive system of a leading New England manufacturer assures every production executive, regardless of grade, a basic salary and a pre-determined share of savings in costs. The flexible budget determines the standard at each level of volume and adjusted compensation is paid to all who show savings under the budget. Compensation is adjusted to responsibility and the terms are understood clearly by all. Each executive is expected and encouraged to earn substantial amounts in excess of his base salary.

Incentives do not always take the form of financial payments. Satisfaction of a job well done and knowledge that higher executives place great reliance upon efficiency in cost control in making promotions often act as powerful incentives for aggressive and continuing progress in effecting savings below standard. One company described by Haskins and Gilmore (N. I. C. A. Bulletin, vol 21) uses no financial incentive plan.

Under this [the budget] process gains become predominant as costs are slowly pulled down and in time a revision of the budget is advisable.

The overseers then meet with the president and the controller to establish a lower objective. The overseers are in accord with the revision policy of the company as they fully realize that costs must continually be reduced to combat declining margins. However, when efforts are made to reduce standards to a point where the overseer feels that quality will have to be sacrificed in order to meet the standard he opposes the reduction.

The overseers constantly strive to show gains on their comparison reports. This philosophy has been instilled by the management because of the absolute necessity for cost reduction of a drastic nature. Strong emphasis has been placed on positive variance and any continued showing of such variances has resulted in more than equivalent reductions in standards thus stimulating further improvement. The president feels that the purpose of the budget is to bring about improvement. As long as progress is made he is pleased but he is never satisfied with the results. Each overseer has been impressed with the fact that he is paid to make things better not to keep them as good as they have been.

Executive attitude toward cost control is the key to success or failure of any system. Foremen and other subordinates cannot be fooled on executive attitude. They know whether their operating results are being carefully studied and followed or only cursory attention is being paid to departmental operations. Active interest and prompt action by executives in rewarding efficiency or remedying weak spots is the surest way to keep the control plan always a vital healthy constructive force for the company.

**Working Conditions**—Among conditions which may be traced to unsuitable working surroundings are: liteness, absence of workers in increased labor turnover with consequent increases in cost of employment and training, low production increased spoilage damage to machinery and tools, higher cost of insurance due to accidents, increased medical costs, higher group insurance premiums and mutual aid costs and low morale of the force. Unsatisfactory conditions are frequently difficult to detect and even more difficult to correct. Nevertheless whatever can be done to eliminate bad conditions usually yields dividends no matter what the cost of improvement may be.

Norton Co. reported that it spent an average of \$4.00 per year on each employee for medical service. In many plants the average runs from \$2.00 to \$6.00, although in some it does not exceed \$1.00.

Costs of maintaining high-grade working conditions vary from plant to plant and depend upon many factors. Part of the problem is solved by correct building design, construction and layout. That which remains, and it is a goodly part, must be handled by the plant management through analysis of shop work and perfection of new and protective devices, physical examinations, safety measures, rest periods, etc., as may be required.

**Working Hours**—Overtime work may be necessary at times to take care of peak loads or to make up for shutdowns, delays or shortages which interrupt production. Frequently they are the result of bad planning, lack of planning or a desire to allow certain workers to make extra money. Sometimes it is cheaper to do overtime work than to add more people to the payroll. In this connection the point to be certain of is that no overtime work is performed without proper authorization given



only after necessity for the work has been clearly determined. With such a procedure it is possible to get it caused for longer hours and eliminate them.

**Ordinary increases of work hours** for the whole force and added compensation for a longer day seldom happen without knowledge and approval of management. It must be assumed if approval is given to increase the working day that compensating benefits be realized. All such changes must be borne in mind when analyzing labor costs in order that the exact cause for increases can be investigated without delay or unnecessary work.

**Honesty Among Workers**—Here is a cause of increased costs which is sometimes difficult to uncover. A workman who falsifies his time ticket, who has a chance to increase the number of inspected and passed parts, or who in order to make bonus or avoid penalty puts rejected parts into the passed lot to cover up his spoilage, causes labor costs to change. Many large concerns have suffered considerable loss because of these practices and have been compelled to introduce elaborate systems of supervision and check to prevent still further losses. Where there is collusion between workers and supervisors, the case is even more serious. Accurate records of time and work, careful selection of workers and supervisors, and close supervision of both are correctives.

**Selection of Machines and Tools**—Total efficiency is the product of man and his machine or tool. A good man cannot turn out standard performance with poor tools nor can a poor man turn out standard performance with good tools. It is never economy to undertake work without the right machines, tools, or equipment. If done the result is to slow down production, spoil work, spoil tools, dissatisfy labor, and not accomplish desired results. Oftentimes poor tools or equipment are due to lack of engineering attention to productive processes and tooling requirements. Elimination of these conditions can usually be secured through good engineering design of tools and machines, proper maintenance of tools, machines, and equipment. It should be emphasized that under average conditions, the individual workman should not be permitted to maintain his machine or tools nor determine his material requirements as to quality.

**Changes in Design of Product**—Sales needs and manufacturing progress are responsible for frequent changes in product design. Unless time study and rate setting work are carefully correlated with engineering changes, it is likely that new operations are introduced or old ones changed without the necessary adjustments in rates and estimated labor costs being made. Other cost elements are frequently involved in such matters and the analyst must not be content to approve a change merely because there appears to be a saving in direct labor costs. Before a new design, or change in present design is put into production, there should be a careful tabulation of cost elements involved to determine the net effect of the change on costs. Even though the final result shows an increase it may be desirable to make the change, but the fact should be known.

**Changes in Machinery, Tools, or Methods of Production**—These operate in the same manner as a change in design and, in general, the

effects produced are the same and manifest themselves in the same way. Plant management should set up the necessary control devices to prevent any changes being made without accompanying cost computations.

**Adequate Accounting or Production Records**—Lack of records makes it difficult to determine accurately the labor or other cost of a job, process, or operation; it makes good control of manufacturing almost impossible, and introduces an element of uncertainty that leaves management in a quandary as to what line of action to follow when apparent irregularities develop. Lack of records paves the way for disputes and misunderstandings and friction which are hindrances to production. Management can be certain that adequate and accurate records of costs and production are being kept only after a complete analysis has been made of information required by each foreman, supervisor and executive to enable satisfactory performance of his work.

**DECREASES IN COST OF DIRECT LABOR**—There may be very good reasons why management should look into causes and results which may arise from a decrease in direct labor costs. It is unwise practice always to assume that a decrease represents a gain in efficiency. There may be an aftermath of costly consequence. Decreases in direct labor costs result from contrivance of causes producing wastes and from other easily seen causes. The concern of the management should be to find out in case of a decrease what conditions were responsible for it and how other production factors and costs will be influenced thereby. It must be kept in mind also that permanent effects are not always immediately visible. It often takes a period of time for conditions to manifest themselves or results to be apparent. If management does not lose sight of the fact that underlying conditions, production factors involved and management practices needed to bring about improvement are sometimes removed from phenomena of change with which they are dealing, they will be less likely to stop their investigation before getting to facts. While it may appear in many cases that the effort is not worth while because of the minor character of the change, such is not always the case. Often time and energy given to an investigation of a minor condition or cause of waste forestalls what might later develop into a major cause.

## Analysis of Manufacturing Expense

**BEHAVIOR OF MANUFACTURING EXPENSES**—Overhead costs in most businesses today form an increasingly large portion of the total costs. The control of such costs is also more difficult to accomplish because they are less well understood than costs which are directly chargeable, and because proper techniques have only recently reached a stage of development comparable to that reached much earlier for direct labor and material.

Fixed expenses are generally noncontrollable since they result from management decisions made in prior periods. The change from manual to mechanical processes, for example, generally involves an increase in the proportion of total indirect expense which is fixed and thus narrows the field of management action. Controllable items, on the other hand,

do not vary directly or uniformly with changes in the activity rate and, because of their diverse nature, it is less easy to maintain a quantity control than in the case of direct labor and material.

Determination of the proper allowance for a given expense is the first step in its control (See Section 6 on Setting Standard Costs). Once proper allowances are set control is obtained largely through determination of an **efficiency variance** by comparison of actual expenditures with amounts allowed for a given rate of activity. However, since the expense absorbed differs from that allowed at all but the normal rate of activity, there is also a **volume variance**.

**CAUSES OF OVERHEAD VARIANCES**—The best method of attack is through analysis of the causes of overhead cost variances. These causes are to a large extent the same as the causes producing material and labor variances, since they are bound to react on each other. A change in material specifications may cause excessive spoilage resulting in an expense variance. Poorly trained help or frequent changes in design may likewise cause corresponding wastes in overhead accounts.

The expense variances may be classified as follows:

- 1 Spending variance sources
  - a Using wrong grade of materials
  - b Using wrong grade of labor
  - c Failure to get most favorable terms in buying
  - d Changes in market price
- 2 Efficiency variance sources
  - a Waste of materials
  - b Inefficient labor performance
  - c Failure to curtail usage of materials and services to correspond with output level
- 3 Utilization variance sources
  - a Controllable causes
    - Employees waiting for work
    - Avoidable machine breakdowns
    - Lack of operators
    - Lack of tools
    - Lack of instructions
  - b Noncontrollable causes
    - Decrease in customer demand
    - Calendar fluctuations
    - Excess plant capacity

The primary purpose of expense analysis is to segregate expense components in order to measure **operating efficiency**. To enable the analyst to segregate the cost elements, he must understand what goes into an expense account. That is he must be fully aware of how, for instance, standards are arrived at, how accounts are classified, and expenses accumulated. With this knowledge the resulting figures can then be unscrambled to arrive at basic facts.

**RESPONSIBILITY FOR OVERHEAD VARIANCES**—The first step toward the establishment of control over this class of costs is the placing of responsibility for variances. This requires careful analysis of all overhead items, both fixed and variable, at the time the standards are set. Those items of cost which vary with production must be repre-

sented by flexible standards, the responsibility for keeping cost within standard limits is assigned to the person in the organization who has authority to control spending usage or utilization. All three of these variance sources may be controllable by the same person, as for example, where a shop superintendent has authority to fix waste rates, determine the number of men employed and the application of indirect labor time, or the responsibility may be divided, as it is where a purchasing department buys indirect materials and is responsible for price, while a shop foreman controls the usage, and the sales department may to some extent at least control the utilization through the volume of sales obtained.

The responsibility for spending and usage variances is not difficult to place, but utilization variances raise a need for analysis of each specific cause to fix personal responsibility. Thus for example, a given utilization variance loss may be a combination resulting from a foreman's delay in providing instructions to an operator, the production control department's failure to maintain an even flow of work, and the sales department's inability to procure enough orders to keep the factory occupied. The important thing here is for the management to ascertain what causes the idle time and who has the authority and responsibility to control it.

Even that part of the utilization variance which arises from so-called noncontrollable causes must be analyzed and responsibility placed for such items may be controllable in the long run by major executives who possess authority to determine what the size of the plant and organization shall be. While estimates upon which capital outlays are based usually can be no more than opinions or even guesses, the success with which executive judgment in such matters is exercised is often a main determining factor in the long-run ability of a business to operate profitably.

The utilization variance is the principal indicator of how well long-run plans concerning productive capacity turn out, because long-lived assets are largely responsible for fixed charges. Hence utilization variances deserve careful analysis to determine personal responsibility and to find remedies for unfavorable conditions. Very substantial utilization losses can often be eliminated by improving equipment, by revising layout, by adding new products, by changing prices, etc.

Even during short periods some definite remedial action can be taken regarding the first two groups, while the utilization variance can at least be substantially reduced. From a long-run point of view all expenses are controllable, although it may be good business policy to incur a certain amount of idle time because the provision of facilities for future growth is often accomplished most cheaply in advance of need, the period of the business cycle favoring acquisition of the needed equipment, or a specific machine may be most economical despite a poor load factor.

**EXPENSE ANALYSIS UNDER HISTORICAL COST SYSTEMS**—If no budgetary control or standard cost system is used, expense analysis is confined to breaking down departmental accounts into their components, comparing each against figures of prior periods, and drawing such conclusions as may safely be made on this basis. Positive con-

elusions are dangerous, since no standard basis of measurement exists as to what constitutes a good or bad performance. The comparison merely shows whether costs were greater or less than those of a prior period, to draw any other conclusion, much effort must be expended to analyze the figures and put them on a comparable basis.

**EXPENSE ANALYSIS UNDER STANDARD COSTS**—Where budgets or standard cost systems are used, the analysis consists of comparing results against predetermined norms and noting variances. For example, the ledger account may show that \$1,000 was spent for a certain buffing compound. By itself or by comparison against a prior period, this figure means nothing. If standards are used, the cost analyst may be able to arrive at a picture somewhat as follows:

Actual cost	
1 000 lbs compound used at \$1 00	\$1 000
Standard for attained volume	
800 lbs at \$1 25	\$1 000

At a glance it is obvious that there has been inefficiency in the form of excessive use of 200 pounds of compound. On the other hand, the resulting loss has been offset by purchasing this item at a price below the standard cost.

**EXPENSE ANALYSIS UNDER BUDGETS**—The budgetary approach to control of costs and expenses is similar to standard costs in use of scientific quantity standards. Unlike standard costs, a budget forecasts actual price and volume conditions rather than relying upon analysis of variances from assumed conditions. Under perfect performance the actual results should conform exactly with budgeted performance. A variation from the budget is evidence of greater or less efficiency and requires no further analysis to assign responsibility for results, assuming, of course, there is agreement as to the validity of the budget.

**Overhead budgets** state amounts for each type of overhead expense to be incurred under forecasted operating conditions. With account classifications paralleling responsibilities, each executive can be completely and promptly informed of performance under his responsibility.

**Flexible budgets** meet the problem of control when conditions (particularly volume) depart from those forecasted. The goal is to predetermine the amounts for each type of overhead for all levels of activity that may be incurred during the coming operating period. This requires separation of all overhead items into fixed, semi fixed, and variable elements. In this way, the cost analyst can determine the rate of expenditure for each volume of production. Each element can then be examined as to its actual cost and compared with the budget allowance at the attained level of production. (For full discussion of Flexible Budgets, see Section 23.)

#### **MANAGERIAL CONTROL AND FLEXIBLE BUDGET—**

When deviation from normal output volume takes place, a flexible budget automatically sets before the various executives the corrected standard for the output level actually achieved. With such standards always in view, it becomes a relatively easy matter to keep the rate of spending of each item of overhead adjusted to the rate of output, i.e.

each item is kept within limits predetermined to be proper with almost the same ease with which the direct costs are made to vary with output. This does not of course mean that these overhead costs can be made to vary proportionately with output, but only that each overhead item is controlled by requiring it to flex with the output at flat rate which has been set previously as a standard for the particular expense.

For example assume that the flexible budget shows that foremanship should be obtainable at a certain monthly cost for each output level covered by the budget. With this schedule before him the plant superintendent can tell at a glance how many foremen he should have on duty and how much they should cost at any particular level of activity which happens to be current. He also knows that any failure to keep within this budget inevitably appears as an unfavorable cost variance charged against him, that the fact will come to the attention of his superiors, and perhaps will also reduce the bonus that he might earn. Under such circumstances there is no hesitation about curbing expenses when the output falls off, or increasing them to provide needed services when the output rises. Furthermore the amount of such changes in spending is determined not by guesswork but by careful study of what the real needs of the situation are likely to be. It is only under such an application of flexible budget standards that genuine control over **variable overhead costs** can be obtained.

Analysis for control under flexible budgets is described by Mutin (N A C A Bulletin, vol 20)

Plans must be followed, accomplishments must be checked and failures analyzed. This means analysis of current expense in comparison with budget allowance and forecasts. Weekly, each department head is given a statement for the previous week of departmental direct labor in total and of indirect labor expenditures by accounts. These detail figures are summarized by departments on a suitable form and the departmental budget allowance posted. The difference between actual and budget are shown for the week and cumulatively for the fiscal year. The "realization percentage" is the ratio of budget allowance to actual expense for the week and for the year to date are shown. Provision is made for pertinent remarks by departments and any general remarks that will facilitate interpretation of the figures can be written as a part of the report. Through this report which is prepared weekly the management can obtain an immediate and comprehensive analysis of the indirect labor in the plant. Attention need be devoted only to those departments which show an overexpenditure for which there is not a satisfactory explanation. In short control of expense labor is accomplished by control of variance from standard.

**BUDGET COMPARISONS**—Satisfactory operation of departmental budgets depends upon frequent comparisons of budget allowances and operating performances. The budget report may be daily, weekly, or monthly.

A weekly budget report for a weave room in a textile plant is described by Harkins and Gilmore (N A C A Bulletin vol 21) and shown in Fig 8. Here the measuring stick is units of production rather than the more common basis of direct labor dollars. Standard figures for direct labor and indirect labor are derived from actual production of cloth multiplied by unit standard costs. Direct comparison of actual and standard gives gain or loss by functions for the week. This report

## WEAVE NO 1 &amp; 2

Standard Looms 1920

Week Ending Feb 8 19--

Actual First Shift	1464
Second	1469
Third	1395
	1318

Standard Yards	500 000
Actual	674 141

OCCUPATION	CODE	STANDARD	ACTUAL	DIFF	LOSS
Supervision and Clerical	001	\$ 654 91	\$ 706 54		\$51 63
Direct					
Weavers	135	* 626 74	7 610 88	\$ 15 86	
Painters In	1 3	483 70	485 70		
Spool Boys	1 4	8 04	19 49		11 45
Total Direct		8 120 48	8 116 07	15 0	11 45
Indirect					
Piers	etc	etc	etc	etc	etc
Oilers					
Cleaners					
Sweepers					
Watch Man					
Inspectors					
Miscellaneous Men					
Smith Pieces					
Battery Hands					
Filling Carriers					
Warp Luelers					
Cloth Trucks					
Head Filling Man					
Filling Conditioner					
Filling Conditioner Help					
Jacquard Head Cleaner					
Harness Repair Man					
Doupe Repair Man					
Head Twister					
General Repair Man					
Instructors and Student					
Cut Stampers					
Total Indirect		7 429 48	7 209 04	189 01	66 47
Total Direct and Indirect		15 542 00	15 415 01	64 87	77 02
Net Gain		126 95		126 95	
Lenses			*1 04		
Allowances			89		
Samples			365 06		
Charging		1 508 13	864 91	643 19	
Extra Work			80		
Inventory			26 73		
Total Payroll			17 423 41		

Std Loom Hours	156 000
Act	179 464

% of Actual to Standard	99 2%
% of Actual Indirect to Direct	89 0%
% of Relative Activity	93 5%

FIG 8 Weekly Budget Report

is presented to the foreman two days following the end of the work week and has a marked effect upon his ability to attain timely and efficient control of operations.

A method of budgeting and reporting the departmental indirect expense is illustrated in Fig 9. The company in question predetermines weekly normals for each type of indirect expense at various levels of activity. The capacities are determined on a weighted basis by converting productive hours in each department to a burden absorption basis. This is done by multiplying burden rate of each machine or bench in department by productive hours per week. Klem (NACM Year Book, 1935) describes the preparation of this report as follows:

After the budget sheet for each department has been accepted by the department head and approved by the plant manager, a copy of his approved departmental budget is given to each responsible foreman or supervisor. This is his control sheet outlining in advance the fair expenses that may be incurred for the various rates of activity over which his department is expected to operate. Promptly at the close of each week the actual capacity worked is determined for each department by relating the actual burden absorbed to the 100% burden absorption.

The department in this case is Foreman Brown's. It was found that the actual ratio of capacity worked was 76%. He accordingly selected the nearest set of established normals, which in this case was 75%, and inserted them in the weekly budget column of Fig 9. The actual weekly expenses as tabulated by the accounting department were then entered in the 'actual' column and the period figures were accumulated. Comparisons of budget and actual were then made and had there been any exceptional expenditures they would have been circled or otherwise marked with possibly some notation or comment on the reverse side of the sheet.

In this way budget reports are prepared for each productive department basing its allowances on the capacity worked by each and for all service departments basing their allowances on the general plant capacity worked. Duplicate sets of these budget sheets are then given to the plant manager or superintendent who may note comments or suggestions on them. He then forwards one to each foreman or supervisor and retains one set for his follow up file.

**Degree of Analysis**—Detailed analysis of each department need not always be made. When the periodic departmental reports point to an unusual condition it is time to go into detail. The question of what to look for depends to some extent on the kind of department. The composition of the departmental costs tends to vary with the nature of the services. All departments have certain expenses in common, among these are such items as

- 1 Supervision
- 2 Clerical salaries and wages
- 3 Vacation expenses
- 4 Sickness expenses
- 5 Supplies

Each department, however, tends to have expenses that are peculiar to it. For example, engineering department costs certainly include experimental expenses. The purchasing department might include buyers' salaries and certainly traveling expenses.

In order to measure departmental efficiency, the accounts must be analyzed to show separately



DEPARTMENTAL INDIRECT EXPENSES BUDGET AND ACTUAL					
- A -		Dept		Week ended June 15, 19	
Brown		F am		76 P Co Capacity	
NO		1 WEEK		1 YEAR	
		BUDGET	ACTUAL	BUDG	ACTUAL
03	Light				
04	Gas for Office	20 00	20 00	667 00	667 00
11	Oil & Sweeper & Gas	4 00	5 00	92 00	92 21
12	Int. T. Transportation	8 00	9 00	184 00	207 12
13	Telephone	5 00	2 00	113 00	109 14
14	Idle & Lost Time				
15	Oil & Diesel (Lab)	38 00	27 00	805 00	765 42
	TOTAL Diesel (Items 11-15)	82 00	43 00	1,196 00	1,177 20
20	Freight				
21	Shed				
22	Machine Road & W. S.				
23	Shed & F. S.				
24	Oil & Gas and P. S. & W. S.	4 00	14 00	59 00	108 08
25	Oil & Gas for W. S.	4 00	3 00	92 00	84 22
26	Shed & Office & Appl. S.	1 00	-	20 00	19 51
27	Machine & Suppl.	2 00	4 00	46 00	51 02
28	Purchase Electricity				
	TOTAL Gas & Suppl. S.	10 00	21 00	230 00	256 73
41	Building				
42	Machinery	33 00	6 00	759 00	694 25
43	Material	6 00	6 00	138 00	142 28
44	Small & Tools & Material	127 00	112 00	2,921 00	2,793 09
45	Internal Transportation Equipment				
46	Cutting Equipment				
47	Office & Office Appliances				
48	Fixed Equipment				
49	Plant				
50	Material & Equipment	2 00	-	46 00	32 89
	TOTAL Plant	360 00	127 00	3,364 00	3,681 26
60	Repairs & Maintenance	3 00	-	69 00	112 15
68	Employment Welfare	2 00	1 00	46 00	58 00
71	Miscellaneous Expense	3 00	2 00	69 00	52 42
	Total Sundry	8 00	3 00	184 00	212 57
	TOTAL ABOVE CHARGES	267 00	223 00	6,141 00	6,003 29
02	Freight	42 00	25 00	966 00	898 00
	TOTAL Freight (Excl. of Freight Charges)	309 00	228 00	7,107 00	6,898 29
	Variance (Black-White, Red-Black)		53 00		208 41
	Other Items				
	Cost per Direct Hour				

FIG 9 Departmental Indirect Expense Budget and Actual

- 1 Expense items which measure efficiency of performance (control  
able costs)
- 2 Expense items which measure plant activity costs (capacity or  
volume costs) Such costs are influenced by the behavior of fixed or  
partly fixed expenses

(See discussion of Idle Capacity Costs in Section 20)

**Segregation of Controllable Costs**—Accounts should be divided under individual responsibilities to show the nature of expenditures. Every executive has within the scope of his task a number of different responsibilities. A foreman for example, has charge of direct labor in his department, several classes of indirect labor and probably certain types of materials. To give him information on total costs for his department is not helpful. He must be informed on each important type of detailed responsibility in his charge. Only under such conditions does he have facts necessary for the proper planning and for checking performance of each aspect of his job.

**Prorated Departmental Expenses**—Total departmental costs always include some items which arise from outside the department and which are **not controllable** by the department executive. The department's share of building costs, depreciation on machinery, expense for heat and power, and in many cases maintenance of buildings and machines are examples of this type of allocated costs. Such items are an integral part of the cost of making products in the department, but their control responsibility lies elsewhere in the organization.

Fiske (World Power Conference, 1936, vol. 4) emphasizes the importance of these distinctions.

An unavoidable difficulty appears in all attempts to base control on unit costs lies in the nature of such costs. They are averages computed by dividing the compilations of many cost elements by units of product. If a unit cost is high it becomes necessary to analyze the amount into its component elements in order to determine what factors are responsible for the increase. Such a study is certain to show some factors which are uncontrollable some which are controllable but by some other executive than the foreman of the department in question and only a portion for which the particular foreman can be held responsible. The unraveling process will carry the investigator back through prorations which may be responsible for the increase to a wide group of individuals ultimately responsible for the increase in unit cost. This difficulty can be overcome only by an accumulation of expense items by types (power supplies etc.) in terms of individual responsibilities and with the distinction between controllable and uncontrollable items fully recognized. A foreman's report prepared on the basis of figures collected can show separately the costs of supplies, sweepers, operatives, power and similar items amounts which can be interpreted in control terms without need for breakdown and for which the foreman can be held directly responsible.

It is for these reasons that many authorities advocate exclusion of prorated costs in control reports. To place, or appear to place responsibility where there is no ability to control is held sure to discourage cooperation. Thus Reitel maintains that only direct expenses should be placed under the responsibility of the foreman. Instead of prorating the joint expenses, such as shop accounting, plant police, etc., he advocates putting these into the general manager's or superintendent's overhead budget where no prorating is necessary. By following this principle,

MANVILLE MILL COST SHEET												In 39 1/2"	
Inquiry No.		For		O in 7/19				Style No 2000					
F bale		Marquisette		On truck 39 1/2 52				x 24		Y/P			
Type Loom		C & K		No Loom		8		Speed 118		CM & 75			
Bale Cotton Price		K500		Shap		R per Price		Shap		Y/P			
YARDS 32-11 1/2													
COST PER POUND												COST PER YARD	
KIND	Yards	Labor	Fixed Expenses	Variable Expenses	Total	Lb per 100	Labor	Fixed Expenses	Variable Expenses	Total	Yards		
45CP17	Wp	2026	1744	979	374	278	3375	5.68	99	56	21	192	
45/2 2nd	Wp	72	1772	1594	629	146	1373	40	07	06	03	17	
	Wp	2098					70	6.08				04	
	Wp												
	Bel												
50CP17	FM	24	1736	846	308	253	3174	241	42	20	07	06	
8KP12	FM	8	1294	377	88	53	1812	501	65	19	04	03	
	FM	32											
	FM												
Warp Preparation per Yards		Labor	Fixed Expenses	Variable Expenses	Total	WARP PREPARATION							
Top Beam						W m & P on Work			119		119		
Slashing T p Beam						W m & D y Labor & E p			80	33	21		
Slashing Bottom Be m		055	027	020	112	Shedding			10	03	02		
Drawing 1 485		113	029	009	151	Cloth Room			34	07	01		
Twisting In 218		051			051	Pack & M t n t					03		
Starting Up 725-4300		169			169	Tax 444			17		17		
B m p		100			100								
TOTAL		488	066	029	583	TOTAL		393	213	410	85		
Weaving Place R is		01032				Allow t O t t		185	04	08	02		
W m p O y Lc		28786	+ 57		344.86	Feet i g					10		
W m p Fixed Exp.				142		Slashing Convrt					09		
W m p V Exp				91		TOTAL		217	418	87	80		
W m p C into				377.86		Selling Pte d E pen				08	08		
Reed Space		43.1				Admnl tative				14			
						Depreciation				17	31		
WARP INVENTORY VALUE						Full Cost per Y m		217	418	126	88		
		Cloth Yard	Warp Y m			BASIS OF CALCULATION							
		Cost	Cost	Shap									
Top Beam					Selling Pte d E pen		Y m Loom B m			Yards			
Bottom B m					Minimum Order		10 27						
		Loom Fixers		41									
		Smash Pieces		05									
		Battery Bands		13									
		General No 1		21									

FIG 10 Standard Cost Sheet

DEPARTMENTAL COST REPORT											
D to		MONTH						TO DATE			
	Ac ct	Bkly (1)	Stand d (2)	A l (3)	Op e (4)	V l m (5)	S d e d (6)	A c t l (7)	D e b t (8)	C r e d it (9)	B a l a n c e (10)
DIRECT LABOR ON STD		261									
INDIRECT LABOR											
Direct Labor (P W I)		79									
Indirect Labor (S J)		211									
Indirect Labor (H B L)		214									
Indirect Labor (S J)		18									
Indirect Labor (S J)		2.3									
Indirect Labor (S J)		2.2									
Indirect Labor (S J)		2.3									
Indirect Labor (S J)		2.4									
Indirect Labor (S J)		2.5									
TOTAL INDIRECT LABOR											
TOTAL LABOR											
INDIRECT EXPENSES											

Tot Ch	Ma Infr	1	Ct								
N - chg 1 direct V	( )		NCIV								
			NCIP								
B - gpt 2 V 1 V 1			NCIP								
TOTAL INDIRECT EXPENSES											
TOTAL COST AND VARIANCES											

FIG 11a Departmental Cost Report (face)



never is the accounting department embarrassed by having to justify an arbitrary splitting of expenses and budgets among several cost centers. This rule however, does not prevent the prorating of certain expenses for costing purposes. It is merely intended to avoid charging the foreman with expenses such as rent, that he does not control.

A cost sheet used by a textile plant (Fig. 10) is developed by Hiskins and Gilmore. It is designed to determine standards for one cloth style. Controllable expenses are shown in detail but the complete cost per yard is predetermined by including prorated unit fixed charges. The cost sheet forms the basis for determining budget allowances by departments and also is useful as a check against selling price.

Inclusion of total department costs carefully subdivided by responsibility, has the advantage of informing foremen with the magnitude of costs of departmental operations, while avoiding confusion as to the degree of responsibility. Another advantage of such cost reports is that they constitute a **subsidiary record** to the general books of account for product cost purposes thus avoiding partial duplication of information for dual purposes of product cost and cost control.

**DEPARTMENTAL COST REPORTS**—The departmental cost report used by a rubber manufacturer is shown in Fig. 11. The face of the report (Fig. 11a) lists each item of labor and indirect cost considered controllable by the foreman. On the reverse side (Fig. 11b) are shown other items of indirect charges comprising elements of departmental cost not controllable (i.e., "chargeable") within the department. "Nonchargeable Indirect-Variable" items are controllable by the division superintendent. Although allocated to each department by rates they appear as totals in the reports prepared for divisional superintendents. Similarly, "Nonchargeable Indirect-Fixed" items are allocated from totals reported to and controlled by proper executives.

In column 1 of the report is entered the 'budget' or one-twelfth of the annual budget allotment for the department. In column 2 is entered the standard cost for each item derived by multiplying actual units produced by the standard cost per unit. Actual amounts are entered in column 3. From these data operating or **efficiency variances** and variances due to volume fluctuations are derived and entered in columns 4 and 5 respectively. Segregation of variances into two classes makes possible a clear recognition of causes and enables a foreman to concentrate upon correction of unfavorable variances of an operating nature (column 4).

Performance for year to date is shown as follows: column 6 cumulative standard costs of goods produced; column 7 cumulative actual cost of production; column 8 net cumulative operating or efficiency variance; and column 9 net volume variance.

Another form of report giving an analysis of controllable costs is shown in Fig. 12, which illustrates results by cost centers and in Fig. 13, which represents a detailed budget report for a gun preparation cost center. Perry (NACA Year Book, 1941) describes these reports as follows:

Fig. 12 is the summary report, showing by cost centers the total cost of operation total covered by the standards the variations an analysis of variances by causes and the build up of the department foreman's budget. These figures are just the totals for the departments or cost centers and,

	CAUSE OF VARIATIONS				FOREMEN'S BUDGET			
	Standard Cost	Actual Cost	Cost Variations	Level of Operations	Management Changes	Foremen's Efficiency	Budget Allowance	% Actual of Budget
SERVICE COST CENTERS								
Boiler								
Power								
Plant and Building								
Machine								
Trucking								
Design								
Pattern								
Gen Administrative								
TOTAL	\$ 22 097	\$ 48 201	\$ 26 896	\$ 1 726	\$ 702*	\$ 2 872	\$ 51 073	94.4
[Detailed figures purposely omitted]								
PRODUCTIVE COST CENTERS								
Yarn Preparation†								
Bobbin								
Warp								
Weaving								
Mending								
Bleach								
Dress								
Cutting and Splitting								
Finishing								
Wrap and Label								
Stock Room								
GRAND TOTAL	\$144 864	\$1 5799	\$6 060	\$5 150	\$1 110*	\$2 025	\$140 524	98.6

\* Denotes rel figure

† See Department Report (Fig 13)

Fig 12 Analysis of Variations by Cost Centers

of course this is prepared after the detail has all been covered. Fig. 13 shows the detail budget for one of the cost centers. This is all that the foreman receives. The official in charge reviews the operating budget of each department with its respective foreman. Any request for additional information arising during this conference are referred back to the cost department.

According to Lauer and Boettcher (NAC A Bulletin vol 19) control over individual departmental expenses is exercised through departmental standards. These do not include fixed charges etc. over which the foreman has no control. They state:

#### VARN PREPARATION COST CENTER

	Budget Allowance	Actual Cost	Over Budget	Under Budget
<b>LABOR</b>				
Winding Spool Yarn	\$1 307	\$1 241	\$	\$ 66
Winding Warp yarn	172	19		33
Winding Bobbin Yarn	120	120		
Back winding	55	55		
Stripping	70	70		
<b>MATERIALS</b>				
Paper	4	2		2
Sizing	15	40	5	
<b>BURDEN</b>				
Supervision	290	364	74	
Handling	331	229		102
Repairs	42	21		21
Depreciation	470	429		41
Insurance	25	23		2
Taxes	228	229	1	
Share of Boiler	152	124		8
Share of Power	117	110		7
Share of Plant and Bldg.	200	186		20
Share of Gen'l Admin.	818	847	29	
<b>TOTALS</b>	<b>\$4 440</b>	<b>\$4 210</b>	<b>\$100</b>	<b>\$209</b>

FIG. 13. Foreman's Budget Report

Weekly we issue a statement of the manufacturing expense by departments to the individual departmental foreman. Fig. 14 shows a sample of this report. In cases of individual departments we submit to them daily a statement of certain of their indirect expenses these items being requested by the foreman and approved by the budget man so that we can be certain that the data we compile will actually be used. Supplementing this we issue daily a report showing the amount of idle time cost by causes and by departments (Fig. 15). You will note the report is detailed by causes and compared with standard in total only. This is done because this element of indirect cost is a very important one in our type of operation and one which is controlled only by close detailed observation on the part of every department head.



## OPERATING REPORT SUMMARY

Department		#23 - Tool Room		Foreman		Mr. John Smith		Date Issued		4/23	
Classification of Expense	Week Ending		4/17		P. end		4/18		4/17		4/23
	Actual	Standard	Actual	Standard	Actual	Standard	Saving	Actual	Standard	Saving	
Indirect Labor	552.	584.	32.	1032.	1123.	91.	11740.	16146.	-2992.		
Supplies	74.	100.	26.	144.	190.	44.	2336.	2317.	-19.		
Tool	267.	300.	63.	344.	609.	275.	9003.	7607.	-1396.		
Main Labor	17.	229.	152.	122.	436.	314.	3309.	4441.	2232.		
Main Material	131.	801.	70.	210.	363.	173.	6018.	4781.	-1237.		
Losses	0.	5.	5.	0.	10.	10.	45.	130.	85.		
Miscellaneous	10.	46.	36.	17.	66.	71.	606.	1093.	487.		
Total Expense	1101.	1845.	364.	1664.	2839.	475.	39577.	36577.	-3000.		
Total Budget Direct Labor	120 24		673 36		126 567		1609 501				
Total Depreciated Expense Charged to Dev. Budget	123		123		123		1192				
Remarks											

Factory Accounting Dept. File

Fig. 14 Daily Operating Report Summary

## REPORT OF MANUFACTURING DELAYS

DEPARTMENT #3 - Misc Vulcanize

Date Issued. 4/23

Today Period Covered 4/9

To Date Period Covered 4/9 thru 4/9

CAUSE			Today	T Date
Insufficient Setup			21 46	95 10
Setup Jobs				
Rearrange Lines			46	7 60
Start and Warmup				23 68
Change Molds			09	83
Clean Molds			10 82	55 96
Repair Molds			13 14	85 86
Repair Tools				
Repair Equipment (Maintenance)			7 49	34 40
Repair Equipment (Tool Room)			09	09
No Stock Scheduled				3 71
No Stock Prepared			11 39	49 14
No Stock Delivered			3 24	15 75
Bad Stock			7 31	25 90
No Inserts			94	37 37
No Plated Parts			1 30	2 64
Traffic Delays				
Tests, Tryouts, Etc.			46	1 58
Missing Cavities			31 08	135 51
Power Off				192 12
Miscellaneous			95	11 69
Standard	Today	T Date	TOTAL	109 42
Direct Labor	1191 42	5548 66	Standard	194 12
Var Rate Per Direct Labor \$		18936	Var from Standard	44 70
				-62 18

Hot Weather Relief

Standard Fixed Amount

Var from Standard

Actual Variable Rate per Direct Labor Dollar

091.64

14056

REMARKS:

F 1 by Accounting Department

FIG 15 Report of Manufacturing Delays

**DEPARTMENTAL EFFICIENCY REPORT**—Standardized operating conditions are essential if true comparisons are to be secured. It is well known that the efficiency of even experienced workers fluctuates from week to week. So long as these fluctuations are small they require no executive attention. However, when a large decrease in efficiency occurs an immediate investigation is needed. Other factors remaining the same, the loss in production or drop in quality is either due to worker or to management. In either case the situation is indicated by the efficiency report, and when the facts are determined, proper remedies can be instituted.

An operating efficiency report for a can filling house of a petroleum refinery is shown in Fig. 16. L. A. Sylvester, who developed this report, says of it:

The daily operation report has been worked out with the idea of not only stimulating the foreman from without but to so equip him that he can see his own efforts in a true light. At the bottom of each day's report the foreman himself computes four percentages or rates:

- 1 Plant capacity utilized
- 2 Efficiency of supervision
- 3 Efficiency of direct labor
- 4 Indirect labor ratio

After a short period of use of these figures a foreman begins to think in terms of them. He is no longer satisfied with a large production at the indirect labor ratio is high; nor is he proud of being ahead of his schedule if his direct labor efficiency is low. At the conclusion of each day he begins to compare results not only with previous days but with what in his opinion the day might have been. From that point it is but a short step to the analysis of the day's work, as it is in progress to bring it to the most satisfactory conclusion. This report derives its greatest force from the fact that it shows the foreman which methods or decisions bring about the best results. In referring here to the daily operation report it should be specifically noted that it is an idea and not some special form that is meant. The actual form must be varied to suit special needs of the group and the nature of the work performed.

**VOLUME VARIANCE**—For the sake of securing stabilized costs predetermined expense rates are established based on normal capacity. Hence in low-volume months a portion of budgeted expense is under-applied while in other months it is over-applied. This difference between budgeted expense and applied expense is a volume variance and represents idle capacity. This is an important measure of cost of equipment and organization not used currently to capacity, or of temporary "savings" rendered possible through abnormal volume. Where external factors cause such variance they emphasize the need for volume and serve to impress upon management the necessity for more intensive sales efforts. Where internal conditions cause the variance increased manufacturing efficiency as a means of lowering costs must be sought. In the latter case, idle capacity is to a large extent the responsibility of the departmental executive.

**Idle Machine Time Report**—Fig. 17 shows an idle machine report arranged to be of specific value to a foreman in reducing this kind of loss. It is for a department or section operating on a 44-hour week which is taken as full capacity. During the week covered by the report,



the total number of active hours was 418 out of a possible 440 indicating operation at 95% of full capacity. Reasons for idle time are traceable principally to the production and planning department which was delayed in getting new work assigned as former jobs were completed.

Another arrangement of idle time report is presented by Fig 18. This form provides columns for the principal reasons or causes for idle time. It gives the number of hours each individual item of equipment is idle, number of hours it should have run based on standard hours of the shop, number of overtime hours run, and per cent of total idle time to

REPORT OF IDLE MACHINE TIME					
Week ending Mar 13 19--			Jim Anderson Foreman		
MACHINE NUMBER	OPERATING HOURS	IDLE HOURS	IDLE TIME BURDEN RATE	COST OF IDLE TIME	REASON
A1	48	2	40	80	No job scheduled in rack
A2	45	1	30	40	
A3	45	1	40	40	
A4	41	3	40	120	Be known
A5	44	—			It is inactive
B1	39		166	635	No job scheduled in rack
P2	41	3	166	315	
C1	43	1	75	75	
C2	40	4	75	300	Rep
C3	4		75	150	No job scheduled in rack
Totals	418	22		1045	
Cost of Idle Time last week			48 30		
Remarks J A. Consultant Planning Dept. Have job cards racked as scheduled in office rather than waiting until jobs are finished					
A V H. 3/15/-					

FIG 17 Idle Machine Time Report

standard hours and also to total hours actually run. This report is a valuable record for the foreman, as it reflects each week the running condition of his equipment showing both success and failure of effort to eliminate idle time. As machine rates are figured on normal capacities, there is no idle machine loss in money unless the machine runs less than normal time.

**SPOILAGE REPORT**—Defective product, scrap, and spoilage constitute an appreciable loss. Holding them to a minimum is one of the important responsibilities of departmental executives. Fig 19 shows a form of report prepared for the foreman to show the amount of spoilage in his department, and who, among his operators, have fallen down on the work. In column form it shows the total number of units produced, those that pass inspection, those that were spoiled, percentage of spoilage, its cost, and a deduction from wages on the basis of 25% of cost of spoilage.

The important step in handling spoilage and defective work is that of analyzing and correcting the causes of loss. Fig 20 presents a form for





a scrap report used in a grey iron foundry. Here is given the history of each man's pouring, both as to number of castings poured and as to causes of defective work. Each molder's record is shown with the amount of scrap for which he was responsible, and reasons for each loss together with scrap for which company was responsible and reasons for its loss.

A report on analysis of finished products damaged in course of manufacture is discussed by Perry (N A C A Year Book, 1941) and shown in Fig. 21. For each loom there is listed the standard cost value of production, weaving damage in dollars and percentage finish damage in dollars and percentage and total damage in per cent of production. This report is presented to the manufacturing vice-president and to the foremen of the weaving and finishing departments.

#### ANALYSIS OF FINISHED PRODUCTS DAMAGED

Loom No	Std Cost Value of Production	WEAVING DAMAGES		FINISH DAMAGES		TOTAL DAMAGES
		Value	% of Production	Value	% of Production	% of Production
1	\$ 13 700	300*	2.2			2.2
2	13 963	315*	2.3			2.3
3	14 573	573*	3.9	200*	1.4	5.3
TOTALS	\$278 648	\$6 500*	2.3	\$2 154*	5	3.1
TOTAL DAMAGES						\$6 654*

\* Denotes red figures

FIG. 21 Analysis of Damaged Products

**CONTROLLING COST OF MAINTENANCE AND REPAIRS**—The most difficult manufacturing costs to control through the budget are those relating to repairs and maintenance. There are two reasons for this:

1. Ease with which maintenance may be deferred
2. Difficulty in placing responsibility

**Deferred Maintenance**—It is relatively easy to defer maintenance and difficult to relate maintenance expense to production volume particularly for short periods of time. When the plant is operating at a high rate maintenance work may interfere with operations and may be held over until the shop is less busy and repairs can be made without any interruptions to operations. For this reason, comparison of actual with budget figures for maintenance for cumulative periods are usually more indicative of how good a job is being done in controlling maintenance costs than are reports for such periods as a week or a month.

For the same reason, many plants stabilize periodic maintenance charges through creation of a **Reserve for Repairs**. Some maintenance account is debited, and the reserve is credited. Actual repairs are charged against the reserve. In this way, the balance in the reserve is a rough measure of the extent to which actual repairs are deferred.



**Placing Responsibility for Maintenance**—In the typical industrial plant there is dual control. Foremen of producing and service departments have the responsibility for seeing that equipment and facilities are so used and maintained, that the cost of their service is kept at a minimum. But few departments have sufficient work to justify the full time of specialized mechanics and repairmen, hence centralization in the form of one or more maintenance departments takes place under a maintenance foreman, chief electrician or chief engineer. Such an executive is responsible for the maintenance requirements of individual departments in the most efficient and economical manner.

The problem arises as to whether costs of maintenance should be handled through a maintenance budget for the plant as a whole with the maintenance foremen held responsible, or whether maintenance allowances should be included in the budgets of departments where the facilities are being serviced. Usually the latter is the preferable solution since the maintenance foreman has little control over equipment usage, and demands made upon the maintenance force are largely under control of the department foreman. If the departmental foreman is held responsible for labor and material cost of maintenance and repair work of his department, he is more likely to see that all such expenditures are justified and to take steps to see that usage of the equipment is such as to keep maintenance costs at a reasonable level. Accordingly, it is considered best practice to include this maintenance allowance in the flexible budgets of the operating departments. At the same time cost accounting procedures may need reviewing to see that they provide for direct charges for all maintenance labor and supplies against departments benefited. It may be desirable in some cases to have the foreman of the producing department approve all time cards and material requisitions where cost is chargeable against his department.

Analysis usually shows that cost of maintenance is a semi-variable cost. Some assets, such as buildings, require repair and upkeep without relation to the rate of operations while others such as machinery, have a maintenance cost which tends to vary directly with the rate of production. For analysis and control it is desirable that total maintenance costs be divided into labor costs and materials and supplies costs. When this is done the effect of labor rate and price changes can be more easily reflected and interpreted. Analysis by classes or types of equipment may also be desirable since the proportion of fixed and variable expense included in maintenance cost of different types of equipment may vary.

**CONTROLLING TOOL COSTS**—Cuttsiff (N. A. C. A. Bulletin vol 21) stresses the importance of considering all factors pertinent to a decision as to the choice of tools. These are listed in Fig 22, which shows the factors entering into the elements of tool cost and also places responsibility for each factor.

The same author, with particular reference to small production output, states that there is only one way to determine correctly the best method for controlling tool costs:

- 1 Obtain the best possible estimate of the number of parts needed over the estimated life of the design
- 2 Obtain tool estimates on all the various methods that can be used
- 3 Determine production costs obtainable with these various methods

- 4 Take a sheet of paper and do a little arithmetic multiply the quantity by the production cost obtainable with each method add to this figure the cost of the tools and then compare the results with the various methods.
- 5 Use good judgment in deciding on the method to use. If one method does not figure out as economically as another but the difference is slight it might still be advisable to select it if possible it might be more fool proof or less open to damage.

## CONTROL OF TOOL COST

Elements of Tool Cost		Responsibility
1	FIRST COST	
a	Production Forecast	{ Production Dept { Engineering Dept { Commercial Dept
b	Selection of Method of Manufacture	{ Engineering Dept { Manufacturing Dept { Tool Division
c	Tool Design	Tool Division
d	Manufacturing Limits on Pieces to be Produced	Engineering Dept
e	Method of Producing Tools	Tool Division
f	Machine Equipment for Use of Tools	{ Manufacturing Dept { Tool Division
g	Ordering of Tools	{ Manufacturing Dept { Engineering Dept
h	Engineering Changes	Engineering Dept
2	MAINTENANCE	
a	Quality of Work Produced	Tool Division
b	Tool Service Ability	{ Engineering Dept { Tool Division
c	Tool Cost per Piece Produced	{ Manufacturing Dept { Tool Division
d	Pieces per Set Up	{ Production Dept { Manufacturing Dept { Commercial Dept
e	Care of Tools	Manufacturing Dept
f	Condition of Manufacturing Equipment	Manufacturing Dept
g	Selection of Lubricants	{ Work & Laboratory { Manufacturing Dept { Engineering Dept
h	Actual Repairing Cost	Tool Division
3	OPERATING PRACTICE	
a	Production Cost per Piece	{ Manufacturing Dept { Tool Division
b	Use of Tools	{ Manufacturing Dept { Tool Division

FIG 22 Control of Tool Costs



Fig. 23 is a **shop order request** for the manufacture of a tool. It provides for showing the quantity of product to be made by the tool, tool description, account to be charged for the tool, and a comparison of the tool cost with alternative methods of accomplishing the same result. This form is useful in bringing into one routine all pertinent elements concerned with a tool decision.

An analysis of supplies and small tools for a special department is presented (Fig. 24) by Wildt (N. A. C. A. Year Book, 1927). Comparative columns show maximum allowance for each of 13 expense items, and actual costs for the period. A third column gives losses and gains for the period. Note that in all cases but three actual cost was below the maximum allowance.

### SUPPLIES AND SMALL TOOLS ANALYSIS

For Department 18—Rm 1

Period Ending April 15, 19—

Item	Maximum Allowance	Actual Cost	Gain or Loss
1—Belting	\$ 4.68	\$ 4.63	\$ 0.85
2—Brooms	2.34	1.40	0.85
3—Emery Wheels	34.32	34.24	0.08
4—Files and File Handles	8.58	3.78	4.80
5—Hand Leather	5.15	0.14	— 0.99
6—Hardening	23.40		23.40
7—Light Bulbs	3.12	1.23	1.84
8—Metal Clamps	15.60	13.26	2.34
9—Oils and Greases	62.40	51.88	10.52
10—Gas	109.26	84.31	24.95
11—Lugs and Waste	9.36	6.71	2.65
12—Small Tools	23.40	30.22	— 6.82
13—Tool Repair	148.20	138.67	— 9.53
	<u>\$449.70</u>	<u>\$420.54</u>	<u>\$29.16</u>

FIG. 24 Supplies and Small Tools Analysis

### Summary Cost Reports

**SUMMARY REPORTS TO GENERAL EXECUTIVES**—It is the duty of the cost accountant to provide the general executives with summarized reports which serve to keep them informed concerning the general conditions within their company and to help them control activities of their immediate subordinates. In general the reports represent the results of the work of the general or financial accountant and the cost accountant. The general accounting department is primarily interested in the compilation of the balance sheet and the profit and loss statement, the forecast of the cash position and such other matters as are of importance in revealing the status of the business as affected by external conditions. The cost accountant supplies the details of operations, particularly those for the **cost of production** which reflect the forces at work internally. The financial statements in conventional form are sufficiently familiar and do not require further illustration. They may be found set forth in considerable detail in the Accountant's Handbook.

(W. A. Paton editor) Concerning summary reports Perry (N. A. C. A. Bulletin, vol. 22) states:

cost report work should start by providing the executives with summarized statements of the month's operation such as the balance sheet statement of operations inventory production sales statistics gross profit analysis and summarized cost figures. These summarized reports are organized into an Executives Handbook which is kept by the executives for quick reference. The purpose of these general statements is to provide the executives with a comprehensive picture of current operations. These reports point out in a general way the costs which are out of line and require further investigation. For example the statement of operations shows the total variations which have occurred in each of the labor material and burden variance accounts. To find the reasons for these variances one must go into other more detailed reports.

The type of report to be furnished depends to a large measure on the type of system in use, whether a historical or standard cost system is used, whether it is of the job order or process cost type. (For details of cost reports under job order or continuous process cost systems see Sections 8 and 9.) The presentation below emphasizes in general the type of cost reports required in connection with standard cost systems, in which great reliance is placed on the use of comparisons. The starting point and principal standard in these comparisons may well be the general budget.

Simplicity and condensation are the keynotes for executives' reports. The latter include the following:

1. Balance Sheet
2. Earnings Statement
3. Plant Summary

The balance sheet (Fig. 25) supplies a quick picture with month-to-month comparisons if desired. An analysis of surplus is provided on the reverse side.

In place of the conventional profit and loss statement, many accountants use an earnings statement (Fig. 26) for submission to the general executives. The statement sets forth the sales volume and a summary of variances from budgeted net profit. The variances are then analyzed showing the effect of each factor listed. Some important ratios appear at the bottom of the form. The reverse side contains a summary of miscellaneous income and charges as follows:

#### PROFIT AND LOSS INCOME AND CHARGES

Miscellaneous Income
Discounts Earned
Royalties Received
Profit on Sale of Assets
Miscellaneous Charges
Interest
Discounts Allowed
Experimental and Development
Noncosted Overhead
Total Net Income and Charges
Budgeted Income and Charges

ASSETS		
	THIS MONTH	REF
11	C h a n g e s in R n k	
12	N e t R i s k	
13	A s s e t R i s k	
21	P r i n c i p a l s	
22	W o r k i n g C a p i t a l	
23	B i d i n g C a p i t a l	
TOTAL CURRENT ASSETS		
40	P r o p e r t y L e a s e	
51	I n v e n t o r y	
52	P r e p a y e d E x p e n s e s	
54	E x p e n s e s P a y a b l e	
56	W o r k i n g C a p i t a l	
58	P r o p e r t y L e a s e	
TOTAL WISC. ASSETS		
TOTAL ASSETS		
LIABILITIES		
61	A c c o u n t P a y a b l e	
62	C r e d i t P a y a b l e	
63	C r e d i t P a y a b l e	
64	A c c o u n t P a y a b l e	
65	O t h e r A c c o u n t P a y a b l e	
66	D i d n o t P a y a b l e	
TOTAL CURRENT DEBTS		
70	R e s e r v e s & T e m p o r a r y D e b t	
82	P r e f e r r e d S t o c k	
83	C o m m o n S t o c k	
85	S u p e r p r i o r S t o c k	
TOTAL PRESENT WORTH		
TOTAL LIAB., RESERVES, & NET WORTH		
WORKING CAPITAL		
RATIOS C A t t e n t i o n D e b t		
S i t t i n g P l a n e		
P r i n c i p a l P l a n e		
P l a n e t t e N e t W o r t h		
P r o f i t N e t W o r t h		

FIG. 25 Condensed Balance Sheet and Ratios

THIS MONTH		YEAR TO DATE	
NET SALES			
Net Income Profit			
Volumetric			
Standard Profit Cost			
Total			
NET PROFIT BEFORE FED. TAX			
ANALYSIS OF VARIANCES			
Mark up (down)			
Volume Method Sold			
Total Markup & Vol			
Differential			
Fixed Cost			
Selling Expense			
Administrative Expense			
Total Contribution			
Per Unit Profit			
Enter Budgetary All			
P & L Net Value			
Total Value			
RATIOS			
Profit to Sales Standard			
Profit to Sales Actual			
Total (Cost of Sales to Inventory)			
Net Profit per Share of Sales			
Return on Investment per Share of Sales			
Sales Activity			
Marketing Activity			
COMMENTS			

FIG 26 Earnings Statement

VARIANCE SUMMARY						
D A T E			Y E A R			
		V	R A T I O S			
			N PLANT MATERIALS USED			
			BRANCH PLANT MATERIALS USED			
			TOTAL MATERIALS USED			
			ADJUSTMENT			
			BAL. NO.			
			TOTAL			
TOTAL	COST CENTER	R	DIFF. ON	E. T. DIFF. BAL. AN.	L	TOTAL
	10. ADJUSTMENT					
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COST & VARIANCE STATEMENT FACTORY						
VS LINE NO.		ACCOUNT	AL BA	T R		ACTUAL
C	DR			MA	CR	
		01 MATERIAL HANDLING				
		02 DIRECT LABOR				
		03 MATERIAL HANDLING				
		04 DIRECT LABOR				
		05 MATERIAL HANDLING				
		06 DIRECT LABOR				
		07 MATERIAL HANDLING				
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		62 DIRECT LABOR				
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		98 DIRECT LABOR				
		99 MATERIAL HANDLING				
		100 DIRECT LABOR				
		DEPT TOTAL				

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FIG 23 Factory Cost and Variance Statement

The plant summary may be in the form shown in Fig. 27. This gives a condensed picture of, in this case, the operations at the main plant by cost centers and of the branch plants as well as of the general selling and administrative divisions.

The plant summary may be further supported by a cost and variance statement (Fig. 28), showing variances by factory account classifications. Similar statements are prepared for the selling and administrative divisions of the plant.

For greater effectiveness these statements may be prepared on strip forms. When placed in their proper binders or folders, two types of comparisons can readily be made without the necessity for rewriting the data. By spreading the forms to the right corresponding columns are exposed giving a complete month-to-month or other periodic comparison. Similarly by moving the forms to the left comparisons are available of the current figures with the cumulative or year-to-date figures.

**RELATION OF SUMMARY TO DEPARTMENTAL REPORTS**—Below the level of the reports just mentioned are the supporting data in the hands of intermediate and minor executives. These reports may, however, be called for by the major executives particularly if they want explanations and analyses of the condensed figures in the summary reports. In general the detail reports cover for the manufacturing division the details of what happens in the cost centers that is the departmental reports. These are the reports furnished to the works manager, plant superintendent and foremen. (For examples of such forms see illustrations and discussion earlier in this Section, also Fig. 29, page 67, and Fig. 30 below.)

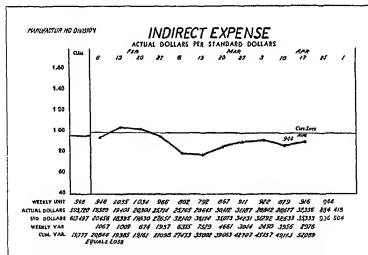


FIG. 30 Indirect Expense—Actual Dollars per Standard Dollars

DAILY PLANT REPORT									
GENERAL MOTORS CORPORATION				PLANT		DATE			
INLAND MFG				DIVISION		February 9			
T O D A Y						MONTH TO DATE			
TOTAL BURDEN	DEDUCT FIXED	ACTUAL VARIABLE	STANDARD VARIABLE	SAVING	SAVING	VARIABLE RATE			
						ACTUAL	STANDARD		
INDIRECT LABOR	4,499	972	3,362	-125	-634	40	38		
OPER SUPPLIES	661	0	973	312	215	10	11		
TOOLS	117	0	177	60	115	2	2		
POWER	1,079	297	1,062	240	769	10	12		
MAINTENANCE-LABOR	734	30	685	181	607	8	10		
MATERIAL	124	19	619	494	1,594	3	7		
LOSSES	1,169	0	973	-196	-57	11	11		
FIXED CHARGES	1,046	949	177	40	141	2	2		
MISCELLANEOUS	-12	99	266	377	626	0	3		
TOTALS-BURDEN	9,477	2,386	8,494	1,343	3,536	86	96		
TODAY		NO TO DATE	YR TO DATE						
ACTUAL PROD LABOR	8,250	32,932	701,130						
STD PROD LABOR	8,646	35,366	721,025						
SAVING-LABOR	598	2,434	19,895						
SAVING-BURDEN	1,343	3,536	-16,341						
TOTAL SAVING	1,941	5,970	1,554						
				DATE ISSUED Feb 10,		TIME ISSUED 3:00 PM			
				SIGNED BY		LBR MANAGER			
				OVERTIME PREMIUMS P.10					

Fig 20 Daily Plant Report

**DAILY PLANT EFFICIENCY REPORTS**—An automobile manufacturer makes use of a daily report covering only the major accounts, both actual and standard (Fig. 29). This report is issued to the general manager and to the executive vice-president. The standards shown on Fig. 29 are established at the beginning of the calendar year and are approved by the executive offices. According to House & Bottlinger (N. A. C. A. Bulletin vol. 19) this daily plant report is an important factor in measuring the performance of the various divisions.

Fig. 30 shows graphically a comparison of actual and standard expense for the manufacturing division as a whole. The plant is operating at 94.4% of standard. Against a standard of \$936,504, the company spent \$881,415, a favorable variance of \$52,089.

### SUMMARIZED EFFICIENCY COST REPORT MONTH ENDING DECEMBER 31, 19—

	Dept. 1	Dept. 2	Dept. 3	Total
<b>MANUFACTURING COSTS</b>				
Total Actual Costs for Month	\$15,275.00	\$18,712.50	\$13,319.75	\$47,307.25
Manufacturing Standard Costs	15,281.25	17,658.25	17,550.30	40,489.80
Net Increase* or Decrease	\$ 1,993.75	\$ 1,054.25*	\$ 769.45	\$ 3,817.45
<b>ANALYSIS OF CAUSES OF VARIATIONS FROM STANDARD COSTS</b>				Increase* Decrease
1. Losses Due to Variations in Direct Labor Costs				
a. Change in Wages				
b. Idle Time of Operators				
c. Inefficiency of Operators	419.25*	311.25*	165.50	\$86.00
2. Losses Due to Variations in Indirect Labor Costs				
a. Change in Wages				
b. Extra Time and Overtime	95.50*	15.00*	15.50	126.00
3. Losses Due to Variations in Materials and Supplies				
a. Change in Prices of Materials				
b. Change in Materials Used				
c. Change in Handling and Storage	117.00*	100.00	160.00*	477.00*
4. Losses Due to Variations in Power Costs				
a. Change in Wages				
b. Change in Fuel and Water Costs				
c. Change in Transmission Costs				
d. Change in Power Overhead	150.00*	152.50*	61.85*	364.35*
5. Losses Due to Variation in Fixed Costs				
a. Variations in Dept. Burden				
b. Variation in Gen. Factory Burden	487.00*	460.50*	299.50*	1,247.00*
6. Misc. Factory Expenses				
Spooled Work			64.10*	701.10
TOTAL ALL DEPARTMENTS	\$ 1,993.75*	\$ 1,054.25*	\$ 769.45*	\$ 3,817.45*

FIG. 31 Statement Showing Variation of Actual Production Costs from Standard Costs, by Items and by Departments

**MONTHLY PRODUCTION COST REPORTS**—Different departments use different applied expense rates and operate at different activity rates. A periodic check on efficiency and volume variances is therefore advisable. A summarized production cost report on a monthly basis placing in comparison the records of three departments is given in Fig. 31. Here total actual costs for month are compared with standard costs and an indication given of net increase or decrease. Then follows an analysis of causes of variations from standard costs under 15 different headings. These cover both efficiency and volume variances.

The report shows a loss on direct labor costs from standard estimates of \$896. Indirect labor shows a variation of \$129 from standard costs. Materials and supplies show a variation of \$477 from standard costs and power costs a variation of \$364.35. Fixed costs show a variation of \$1,247 from standard costs and miscellaneous factory expenses shown as spoiled work show a variation of \$704.10 from standard.

Such a report can take the place of the variance summary (Fig. 27), and it may be supported by detailed departmental reports of the type shown in Figs. 11 and 12.

**INVENTORY CONTROL CHART**—W. C. Skuce describes an inventory control chart, Fig. 32 (N. A. C. A. Year Book, 1933). A decision is made as to the working inventory at capacity and as to minimum or stand-by inventory at zero operation. As the rate of production increases the need for stand-by inventory decreases until it disappears at capacity production. The chart thus acts as a guide to total inventory requirements at any rate of production. At any production stage the actual inventory can be compared with the predetermined inventory and a percentage of realization prepared. The control chart is useful in guiding manufacturing executives to greater efficiency because it emphasizes shorter production cycles resulting in increased turnover and greater return on capital investment.

**GRAPHIC EXECUTIVE CONTROL CHART**—Wallace Clark (A Control Chart for the Chief Executive) has developed a Gantt type operating control chart or graphic report on operating conditions (Fig. 33) to give an executive a basis for action. The purpose of this graphic report is to make immediately apparent that a certain result is satisfactory or unsatisfactory. This determination is made by comparing results with a predetermined plan or standard. The executive decides in advance what conditions or progress he desires and secures reports at regular intervals which compare actual conditions with those predetermined. Comparisons presented concern the attitude of mind of customers toward the company as revealed by quality of product and service rendered. They also show what work is ahead in plant, orders received month by month, data concerned with the operation of business including costs and expenses, idleness, inventories and finally pertinent facts regarding the working force such as accidents, labor turnover, earnings and individual production. For each of these items schedules of standards are developed and actual performance is plotted against these predetermined figures.

Reports in this form indicate whether or not progress made is satisfactory or unsatisfactory. If performance is reasonably close to plan, the executive can safely dismiss the matter from his mind. If, however,

actual performance falls below standard, he can delegate a member of his staff to bring in reports in further detail. Causes of unsatisfactory conditions can be discussed and action planned to correct the situation. If in contrast to this situation actual progress is better than scheduled the chief executive can compliment his staff and take steps to bring other activities in pace with the one which is ahead of schedule. The chart shows all pertinent data in connection with quality and service, work ahead, orders received, operating data, and personnel.

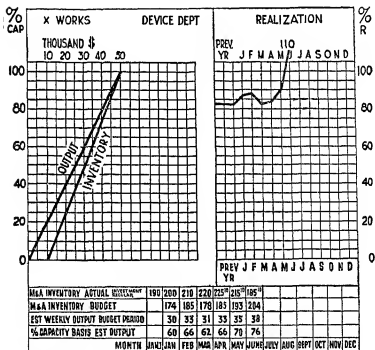
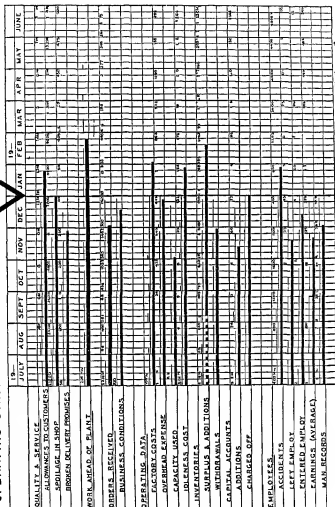


FIG 32 Inventory Control Chart

Work ahead on item by itself, shows what per cent of capacity of the plant is covered by orders. Orders received are plotted against monthly sales quotas. Business conditions are a forecast of general business activity. Operating data include factory costs, overhead expense, capacity used, idleness, cost inventories, and changes in capital accounts. Reports on employees concern accidents, number left employ, number entered employ, average earnings, and man records made up from a duly production record of each workman compared with a definite standard.

# OPERATING CONTROL CHART



PLAN T INDEX EEO HART

FIG 33 Executive Control Chart

**CHECKING EFFECTIVENESS OF REPORTS**—Many methods are in use by controllers to check the validity and effectiveness of reports. A report once valid may become less so. Reports prepared for special purposes are often not discontinued when the need has passed. Bachelor describes this point (N A C A Year Book 1941):

Our experience has been that once a report is issued and falls into the hands of several people it is extremely difficult to eliminate. However, once each year we attach to each copy of every report issued a small fly sheet asking the following:

- 1 Does this report serve a useful purpose in your hands?
- 2 Have you any suggestions for improvements?
- 3 Should it be continued?
- 4 Can it be discontinued?

Each person receiving a copy of the report is required to answer the questions on this fly sheet. Fortunately for us the president of our company personally interests himself in this check up on elimination schedule.

**Staff Meetings**—A strong force in promoting cooperation among departmental executives and securing their goodwill is through weekly meetings at which their problems and their performances are reviewed. The meetings also serve as follow-ups to the daily reports. In this connection House & Boutger (N A C A Bulletin vol 19) state the practice of the Inland Manufacturing Division of General Motors Corporation where weekly meetings take place attended by general foremen and department heads. The factory manager presides.

The method of procedure is first to review the division's performance with regard to any element of cost and after the review of the total performance of the division we take up the performance of each department. If the performance of the division as a whole is good our usual procedure is to point out the performance of those who contributed to this favorable performance. On the other hand if the performance of the division as a whole is bad the departmental review is one of criticism of those who have caused the fall down. We try to work out with the foreman at these meetings any problems he may have. He is permitted to state his side of the case and from the discussion in these meetings frequently come the suggestions and plans that mile for cost betterment.

This company believes in furnishing all cost data possible to the foreman so that he is not merely a foreman in the old sense but in reality a departmental manager, who not only maintains a schedule, but does so economically.



## SECTION 2

### VARIATION ANALYSIS

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## SECTION 2

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### VARIATION ANALYSIS

#### Cost Variations and Standards

##### CHECKING PERFORMANCE AGAINST STANDARDS—

Having determined a proper standard cost for any given article the executive may dismiss the question of cost from his mind until such time as there is a discrepancy between the actual and standard cost. It is the prime function of the cost accountant to draw the attention of the operating executive promptly to the existence of such discrepancy or variation. When a significantly large cost variation appears management should be able to analyze it and determine where it occurred, who was responsible and why it happened. This analysis requires that cost records show in what department the variation occurred, then from a knowledge of the organization, the person responsible is located and physical inspection shows the cause of the variation.

The process of currently checking actual performance against standards is the function of two departments:

1. Inspection department which carries out comparisons with physical standards
2. Cost accounting department, which collects and classifies the data for comparison of actual with standard costs

From these two comparisons but chiefly from the latter come reports summarizing the results of performance as measured against standards in order that executives may be currently informed concerning the work over which they have authority and for which they are responsible. Both of these activities must be accurately done and adequately recorded.

**PRINCIPLE OF EXCEPTIONS—**The effectiveness of comparisons of actual and standard costs is based on the principle of exceptions which makes it possible for the cost accountant to sift from the great mass of his cost data the essential facts needed by management. Cost variations may be regarded from two angles:

1. From the standpoint of the variation in the cost of the individual article of product, or operation
2. From that of the basic cause of the variation

For example assume a standard set up cost of \$10 for a given operation based on a standard run of 100,000 units of product. This yields a standard set up cost per 100 pieces of \$01. Now, assume that due to spoilage in a subsequent operation it is necessary to make a special

to run of 1000 pieces. The new set-up cost of \$10 must be absorbed by 1% of the standard run of 1000 pieces yielding a set-up cost of \$1 per 100 in material of \$9 or 9.900%.

**ANALYSIS OF VARIANCES**—When standard costs are in use the control of costs requires that variances from standards be collected and studied in order to determine how they may be improved in the future. Since the total difference between the actual and standard cost is composed of variances arising from a variety of causes it is necessary to resolve this total into its component parts in such a way that the contribution of each causal factor can be isolated. This is accomplished by taking the factors one at a time while assuming that the other factors are held constant. Thus it is possible to calculate the influence upon cost of each cause of variation.

The results are affected by the kind of standard in use. If ideal (i.e. efficient) standards are used the variances cannot be entirely eliminated, and management must decide how much of the variance represents avoidable inefficiency and how much is merely human inability to attain maximum efficiency. The part ascribable to the former cause is the responsibility of someone within the organization but the second cannot fairly be so treated.

If the standards represent the performance actually expected, all variances can be assigned to the persons responsible for the maintenance of the standards. Standards which have been inaccurately set may be either unreasonably high or so low that waste and inefficiency pass unnoticed. These matters become especially important when incentive compensation plans are based upon performance relative to standard cost but even when employee earnings are not affected by variances good standards and a fair interpretation of variances are essential for both maintenance of satisfactory personal relationships within the organization and effective control of costs. Each person must be made to feel that his work is being measured by a standard of reasonable expectation.

**COMPUTING MATERIAL AND DIRECT LABOR VARIANCES**—The method illustrated below represents a mechanical arrangement of the data (Fig. 1) which makes possible the automatic computation of variances by totals and in detail. Under this method an overall variance is first obtained, this is then broken down in the case of material into usage and price variances. The advantage results from the fact that unskilled clerical labor may be used to make the necessary computations.

The basic assumed facts in Fig. 1 appear in columns 1 to 5 inclusive. Information in columns 1 and 2 is taken from the standard cost card. Column 3 is based on stock ledger cards or other records. Column 4 the standard quantity in the product is based on production records combined with standard and physical requirements as shown by the standard cost card. Column 5 of course represents actual production figures taken from the daily or summary production reports. The remaining columns are merely different combinations of the information in the first four. Thus the over all variance is obtained by comparing the standard quantity at standard rates with the actual quantity at actual rates (col. 6 minus col. 8). The resulting figure is used as a check figure against price and usage variances.

The difference between columns 6 and 7 in Fig. 1 shows usage or quantity variance. This is because both columns use standard rates and holding

(1) Type of Material	(2) Standard Unit Cost	(3) Actual Unit Cost	(4) Standard Quantity (in product)	(5) Actual Quantity	(6) Standard Quantity at Standard Rate	(7) Actual Quantity at Standard Rate	(8) Actual Quantity at Actual Rate	VARIANCES		
								Over All (9) — (8)	Usage (8) — (7)	Price (7) — (8)
M-1	\$1.00	\$ .85	500	520	\$ 500.00	\$ 520.00	\$ 442.00	+\$ 58.00	— 20.00	+\$ 78.00*
M-2	7.00	7.70	900	206	1 400.00	1 436.00	1 078.50	— 178.50	— 82.00	— 143.50
M-3	2.00	2.20	1 080	1 080	2 160.00	2 160.00	2 376.00	— 216.00	0	— 216.00
Totals					\$4 060.00	\$4 116.00	\$4 396.50	— \$336.50	— \$92.00	— \$91.50

\* — = Unfavorable variances + = Favorable variances

Fig 1 Material Cost Variances

(1) Operation	(2) Standard Hourly Rate	(3) Actual Hourly Rate	(4) Standard Hours (in product)	(5) Actual Hours	(6) Standard Hours at Standard Rate	(7) Actual Hours at Standard Rate	(8) Actual Hours at Actual Rate	VARIANCES		
								Over All (9) — (8)	Time (8) — (7)	Rate (7) — (9)
1	\$ .50	\$ .50	500	575	\$ 250.00	\$ 262.50	\$ 282.50	— \$ 12.50	— 21.00	\$ 0
2	.60	.65	1 200	1 540	900.00	924.00	1 001.00	— 101.00	— 24.00	— 17.00
3	.75	.80	900	230	140.00	172.50	154.00	— 4.00	— 7.50	— 11.00
4	.05	.00	560	560	\$ 532.00	\$ 532.00	\$ 604.00	— 28.00	0	— 28.00
Totals					\$1 802.00	\$1 901.00	\$1 951.50	— \$ 89.50	— 52.00	— \$80.50

Fig 2 Direct Labor Cost Variances

that factor constant, any difference is therefore due to a material usage greater or smaller than the allowed standard.

The difference between columns 7 and 8 is the price variance. Here the quantity is held constant, hence the difference is due to a price departure from standard. Cross totaling columns 10 and 11 should give the totals in column 9. To get the combined variances on all materials total all columns from 6 to 11 inclusive, and cross check them.

The same method is used to obtain variances for direct labor (Fig. 2). Efficiency is represented by a time variance and price by a rate variance. For greater clarity, these are often in turn subdivided. Thus efficiency is affected by the presence of leanings and a special allowance must therefore be made on this score so that the foreman is judged only as to conditions under his control. Again the rate variance is affected by the presence of overtime paid for at premium rates. Such overtime should be set forth as a separate variance in order to show the true extent to which basic wage rates have changed.

**ANALYZING OVERHEAD VARIANCES**—There is no uniform method for analyzing overhead variances. Different practitioners and textbook writers show a variety of formulas in making such analyses. They fall roughly into four groups, as follows:

- 1 Capacity and controllable variance
- 2 Efficiency capacity, and budget variances
- 3 Efficiency capacity and expense variances
- 4 Miscellaneous

Figs. 3 to 7 show the results of different methods of overhead variance analysis. They are based on the following assumed data:

	Department A	Department B
1 Budgeted overhead at normal capacity	\$2 000 00	\$3 000 00
2 Standard hours at normal capacity	2 000	1 000
3 Standard overhead per hour	\$ 1 00	\$ 3 00
4 Standard allowed hours for actual production	2 000	800
5 Actual hours run	2 065	780
6 Actual overhead expense	\$2 011 00	\$2 870 00
7 Flexible overhead budget allowances *		
a For actual hours	\$2 032 50	\$2 795 25
b For standard hours in product	\$2 000 00	\$2 400 00
c For attained capacity		
Department A (2 000 hrs = 100%)	\$2 000 00	
Department B (800 hrs = 80%)		\$2 805 00

\* For detailed flexible budgets underlying the above figures see Section 7, Fig. 3 and 4.

**Capacity and Controllable Variances**—Capacity and controllable variances represent volume and efficiency variances respectively. Advocates of this type of analysis are Reitel and Van Sickle, who obtain these variances for direct producing department charges as well as distributed service charges. According to Reitel the following facts form the basis for computing capacity and controllable variances:

- 1 Cleared in cost
- 2 Budget allowance
- 3 Actual expenses

The **cleared in cost** is the amount charged to Work in Process and represents the product of the standard allowed hours for the attained production and the standard hourly rate.

The **budget allowance** is the expense allowed at the attained level of production. It could be expressed as the product of the standard allowed hours and the hourly budget rate for such hours. However, it is usually obtained from the flexible budget. This is done by first determining the attained activity level and then determining the allowed expenses at that level by interpolation, if necessary, in the flexible budget. The **actual expenses** represent, of course, the sum total of the standing orders, i.e. the departmental expense accounts. The computations and variances for this method are shown in Fig 3.

In addition a detailed **schedule of variations** from the budgeted overhead expenses is prepared for department heads to aid them in controlling the expenses of their respective departments (Fig 4) (See also Section 1).

Department	(1) Cleared In Cost	(2) Allowed Budget	(3) Actual Cost	(4) (5) (6) VARIANCES		
				Over All (1) - (3)	Capacity (1) - (2)	Con- trollable (2) - (3)
A	\$9 000 00	\$2 000 00	\$2 011 00	-\$ 11 00	\$ 0	-\$11 00
B	2 400 00	2 805 00	2 870 00	- 470 00	- 405 00	- 65 00
Totals	\$4 400 00	\$4 805 00	\$4 881 00	-\$481 00	-\$405 00	-\$76 00

FIG 3 Overhead Variances (Fetell Van Sickle)

**Efficiency, Capacity, and Budget Variances**—In this type of analysis, a new element is introduced not present in the previous method, i.e. the overhead variances are shown in more detail. Among others the advocates for this method include Blocker, Gillespie, Neuner, Newlove and Garner. Subject to minor differences in terminology, this group displays the following variances:

- 1 Efficiency variance
- 2 Capacity variance sometimes called volume or utilization variance
- 3 Budget variance also called spending variance

Fig 5 shows the method of computation. Note that the results differ from those in Fig 3. In the latter, the **capacity variance** is obtained by comparing the cleared-in cost with the flexible budget allowance for the standard hours in the product. Any difference in the figures is due to the behavior of the fixed charges. The cleared-in cost absorbs overhead at a uniform hourly rate for fixed and variable charges alike, while the flexible budget assigns to each expense a definite amount. In Fig 5, however, the capacity variance is represented by the difference between the actual hours worked and the normal hours translated back into dollar amounts. Thus in Department B idle time is 210 hours (i.e. 1,000 - 790). Since the hourly rate is \$3, the volume variance is \$630 as shown in Fig 5.

The **efficiency variance** in Fig 5 also differs from the controllable variance in Fig 3, because here too the basis of measurement of the

Account	DEPARTMENT A			DEPARTMENT B		
	Budgeted All waste at 100%	Actual	Variance	Budgeted All waste at 90%	Actual	Variance
Supervision	\$ 450 00	\$ 400 00	-\$50 00	\$ 325 00	\$ 2 00	
Indirect Labor	940 00	940 00	— 00	200 00	915 00	-\$15 00
Supplies						
Fuel	etc	etc	etc	etc	etc	etc
Water						
Maintenance						
Depreciation						
Taxes						
Power						
<b>Totals</b>	\$2 000 00	\$2 011 00	-\$11 00	\$2 005 00	\$2 570 00	-\$565 00

FIG 4 Controllable Expense Analysis (Producing Departments)

Depart ment	(1) Standard Hours at Standard Rate	(2) Actual Hours at Standard Rate	(3) Budget at Normal	(4) Actual Expense	(5) Over All (1) - (4)	VARIANCES		
						Efficiency (1) - (2)	Capacity (2) - (3)	Budget (3) - (4)
A	\$2 000 00	\$2 065 00	\$2 000 00	\$2 011 00	-\$ 11 00	-\$ 65 00	-\$ 11 00	
B	2 400 00	2 370 00	3 000 00	2 570 00	- 470 00	+ 30 00	+ 130 00	
Totals	\$4 400 00	\$4 435 00	\$5 000 00	\$4 581 00	-\$481 00	-\$65 00	+\$119 00	

FIG 5 Overhead Variances  
(Gillespie Newlove & Garner Neuner Blocker)



Department	(1) Standard Hours in Product at Standard Rate	(2) Actual Hours at Standard Rate	(3) Possible Hours for April at Stand- ard Rate	(4) Budgeted Hours for Standard Month at Standard Rate	(5) Budget at Normal plus New As- sistants	(6) Actual Expense	VARIANCES					(12) Rate (5) - (6)
							(7) Over-All (1) - (6)	(8) Effi- ciency (1) - (2)	(9) Capacity (2) - (3)	(10) Calendar (3) - (4)	(11) Salaried Staff (4) - (5)	
A	\$2 000 00	\$2 083 00	\$1 973 77	\$2 000 00	\$2 000 00	\$2 011 00	-\$ 11 00	-\$65 00	+\$ 91 23	-\$ 26 23	\$ 0	-\$ 11 00
B	2 400 00	2 370 00	2 990 05	3 000 00	3 000 00	2 370 00	+ 470 00	+ 30 00	- 309 05	- 99 34	0	+ 130 00
Totals	\$4 400 00	\$4 453 00	\$4 974 43	\$5 000 00	\$5 000 00	\$4 381 00	-\$481 00	-\$35 00	-\$439 43	-\$125 57	0	+\$119 00

variance differs in each case. The unfavorable variance in Department A is due to the fact that in order to achieve the normal production of 100 units, 65 hours in excess of the normal time were required. In Department B however, there is a favorable variance because the 80 units of product completed required 10 hours less than the standard allowed time. At \$3 per hour the \$30 variance result.

The budget variance is distinctive in this type of analysis. It is a spending variance, and measures only the rate of spending, as compared with the budget at normal capacity. Thus, in Department A the unfavorable budget variance shows that \$11 more was spent than the budget provided. Since, however, the department operated at normal that is 100% capacity and since all other factors causing variances are accounted for, this variance of \$11 approaches the nature of a price variance. However, in Department B operating at 80%, the variance simply discloses the fact that \$130 less was spent than called for by the normal budget. Since however the department operated at considerably less than normal capacity the two sets of figures—budget at normal and actual expense, are not really comparable and no inference may be drawn from them. The chief utility of the budget variance lies in furnishing information to the financial branch of the business as to the rate at which working funds are being absorbed by the business.

**Efficiency, Capacity, and Rate Variances**—Somewhat similar to the above group is the method of analysis developed by G. Chauncey Harrison. The latter, however, differs in two important respects:

- 1 The capacity variance is analyzed in greater detail.
- 2 There is a rate or price variance in lieu of a budget variance.

Variances developed by Harrison are as follows:

- 1 Efficiency variance
- 2 Total capacity variance
  - a Capacity or idle time variance
  - b Calendar variance
- 3 Rate variance
  - a As to salaried staff
  - b As to hourly workers and other expenses

Computations and results are shown in Fig. 6. The efficiency variance results in the same figures as for the previous group (Fig. 5). The combined figures for capacity and calendar variances result in the same total as for the capacity variance in Fig. 5. The combined totals for salaried staff and hourly rate workers result in a variance similar to the budget variance (Fig. 5).

Calendar variances, according to Harrison are calculated as follows:

- 1 The standard working hours in a standard month are computed (Fig. 7).
- 2 The illustration in Fig. 6 is based on the assumption that the transactions took place in April. Reference to Fig. 7 shows that April has 205 out of 212 standard hours. Hence, the possible department hours are as follows:

Department A  $2\,000 \times \frac{205}{212} = 1\,973.77$  hours

At \$1.00 per hour this is \$1 973.77

Department B  $1\,000 \times \frac{205}{212} = 966.887$  hours

At the rate of \$3.00 an hour this yields \$2 900.66

This seems a rather clumsy method. Others accomplish the same result by making use of the **flexible budget** and getting the allowed expense at the attained capacity. (Detailed discussion of the Harrison technique is presented later in this section.)

MONTH	Days in Month	Hours in Month on 9 Hour Basis	DEDUCTIONS							Working Hours in Month
			SUNDAYS		SATURDAYS		HOLIDAYS		Total Deduction in Hours	
			No in Month	Hours on 9 Hour Basis	No in Month	Hours on 4-Hour Basis	Name	Hours on 9 Hour Basis		
Jan	31	270	5	45	4	16	New Year	0	70	200
Feb	28	252	4	36	4	16			52	200
March	31	270	4	36	4	16			52	217
April	30	270	5	45	5	20			65	205
May	31	270	4	36	4	16	Memorial Day	0	61	218
June	30	270	4	36	4	16			52	218
July	31	270	5	45	5	20	Independence Day	0	74	205
Aug	31	270	4	36	4	16			52	217
Sept	30	270	4	36	5	20	Labor Day	0	65	205
Oct	31	270	5	45	4	16			61	218
Nov	30	270	4	36	4	16	Thanksgiving	0	61	209
Dec	31	270	5	45	5	20	Christmas	0	74	205
Total	305	2785	53	477	52	208		54	739	2546
Allow for Misc Elections Etc									2	
Total Working Hours in Year									2 544	
Total Working Hours in Month									212	

FIG. 7 Standard Working Hours in Standard Month

**Efficiency, Capacity, and Spending Rate Variances**—Camman computes variances much like those shown in Fig. 5. His terminology is different and the results are different. This is because he employs a "basic" or measurement standard cost technique (see Sections 6 and 7). The results are the same if ideal and basic standards are set at the same operating level. Camman's expense variances are

- 1 Machine effectiveness variance like the efficiency variance
- 2 Degree of capacity used variance, like the volume variance
- 3 Spending rate variance like the budget variance

**Efficiency, Activity and Expense Variances**—This group is represented by Schlatter who obtains efficiency, activity and expense variances. Note that activity (capacity) and expense variances differ from those obtained in Figs 3, 5, and 6 because of a different method of computation. The computation for this method is shown in Fig 8 (page 81).

The efficiency variance is identical with that computed earlier. The capacity variance however is different because in the present case it is measured against the budget for actual hours, instead of against the budget at normal. The most pronounced characteristic of this method lies in the expense variance calculation. Fig 8 shows its computation through a comparison of actual expense with budgeted expense for the actual hours worked. In this way something more nearly resembling a price variance is obtained because the actual expense and the budget figure are for the same number of hours, in Fig 5 the comparison of the actual expense was made with the budget at normal.

**Expense Variances**—Lawrence (Cost Accounting) obtains only expense variances and apparently is not interested in volume or other variances. He does however obtain so called cost and quantity variances for indirect labor and indirect material. The cost variances correspond respectively, to the rate and price variances for direct labor and direct material. Similarly, the quantity variances represent the efficiency and usage variances for the above cost elements.

## Cost Variation Formulas

**DEVELOPMENT OF COST VARIATION FORMULAS**—The procedure for obtaining variances may be reduced to a mathematical formula that is a generalized statement or expression employing mathematical symbols. This makes possible the substitution of given figures in the formula and the solution of the latter to yield results for a specific case. The principles involved in the development of cost formulas are comparatively simple. The method of building up a cost formula is illustrated in Figs 9 to 12. All of the cost formulas shown were developed by Harrison (Standard Costs). They are simple equations. Figs 9, 10, and 11 illustrate the development of the simple formula of Fig 12, which provides a means for analyzing a variation in labor costs as between time and rate fluctuations.

The development of a more complex formula is illustrated in Figs 13 to 20 the complete formula being shown in Fig 18. It will be noted that a variation in the cost of so comparatively simple an item as the salary of a factory superintendent is in reality somewhat complex in its analysis as there are five contributing causes.

**CALENDAR VARIATIONS**—Under the plan illustrated in Fig 13 the number of normal working hours in the year is first determined and reduced to the basis of a standard month, which is 1/12th of a year (see Fig 7). By deducting the standard cost for the standard month from the standard cost for the normal working hours in the actual month being considered (see Fig 13), the increase or decrease in costs resulting from calendar variations is readily obtained.

LET  $A$  = Actual Hours at Actual Rate per Hour  
 LET  $B$  = Actual Hours at Standard Rate per Hour  
 THEN  $B - A$  = Variation in Rates (Formula 1)

## EXAMPLE

LET  $A$  = 200 hr at \$0.40 per hr = \$80.00

LET  $B$  = 200 hr at \$0.35 per hr = \$70.00

THEN USING THE ABOVE FORMULA

$$\$70.00 - \$80.00 = -\$10.00$$

That is there is an increased cost due to rate variation of \$10.00

## PROOF

The only difference between  $A$  and  $B$  is that the rate has been increased from \$0.35 to \$0.40—an increase of \$0.05 per hour 200 hours at \$0.05 = \$10.00

FIG 9 Cost Formula Showing Wage Rate Variation

LET  $B$  = Actual Hours at Standard rate  
 LET  $H$  = Standard Hours at Standard Rate  
 THEN  $H - B$  = Variation in Hours (Formula 2)

## EXAMPLE

LET  $B$  = 200 hrs at \$0.35 per hr = \$70.00

LET  $H$  = 150 hrs at \$0.35 per hr = \$52.50

THEN USING THE ABOVE FORMULA

$$\$52.50 - \$70.00 = -\$17.50$$

That is there is an increased cost due to excess time of \$17.50

## PROOF

The only difference between  $B$  and  $H$  is in the time which has increased from 150 to 200 hr

$$50 \text{ hr at the standard rate of } \$0.35 = \$17.50$$

FIG 10 Cost Formula Showing Time Variation

LET  $A$  = Actual Hours at Actual Rate per hour  
 200 hr at \$0.40 = \$80.00

LET  $H$  = Standard Hours at Standard Rate per hour  
 150 hr at \$0.35 = \$52.50

THEN  $H - A$  = Total Variation (Formula 3)

THEN USING THE ABOVE FORMULA

$$\$52.50 - \$80.00 = -\$27.50$$

That is there is a total increase in cost of \$27.50

FIG 11 Cost Formula Showing Total Variation

FORMULA 1  $B - A$  = Variation in Rates

FORMULA 2  $H - B$  = Variation in Hours

FORMULA 3  $H - A$  = Total Variation

Combined Formula

$$H - A = (B - A) + (H - B)$$

Proof of Combined Formula

$$H - A = (B - A) + (H - B)$$

#### EXAMPLE

Total Variation		Variation in Rates		Variation In Hours
$H - A$	=	$B - A$	+	$H - B$
\$52.50		\$70.00		\$52.50
80.00		50.00		70.00
<hr/> -\$27.50	=	<hr/> -\$10.00	+	<hr/> -\$17.50

FIG 12 Combination of Formulas of Figs 9 10 and 11

**ASSUME**

- (1) That the expense is factory supervision which consists of a super intendent at \$500 00 a month
- (2) That the standard working hours in the standard month are 212
- (3) That the cost sheet is for the month of February with 200 standard working hours

**LET**

$C$  = The standard cost for the standard month that is \$500 00 (viz the superintendent's salary)

$D$  = The standard cost for the hours possible in February viz

$$\frac{200}{212} \times \$500.00 = \$471.70$$

THEN  $D - C$  = Calendar Variations (Formula 4)

Applying this Formula

$$\$471.70 - \$500.00 = -\$28.30$$

That is due to the short month costs were increased \$28 30

FIG 13 Cost Variation Formula Resulting from Calendar Variation

The working hours in the month of February should have been 200

But due to a water shortage the plant operated for only 180 hrs

LET  $D$  (as before) = The standard cost for the superintendents salary for hours possible in the month (see Fig 13) = \$471 70

$E$  = The standard cost for the 180 hrs actually worked =

$$D \times \frac{180}{200} = \$424.53$$

Then  $E - D$  = Idle Time Expense (Formula 5)

Applying the above formula

$$\$424.53 - \$471.70 = -\$47.17$$

That is the 20 hr shut-down cost the company \$47 17 for the superintendents salary alone

FIG 14 Cost Variation Formula Resulting from Plant Shutdown

Assume that the standard production per hour is 1 000 pieces

In 180 hr that the plant was operated the production should therefore have been 180 000 pieces

Assume that production was 160 000 pieces

Let  $L$  (as before) = The standard cost for the superintendent's salary for the hours actually worked = \$424 53

Let  $H$  = the standard cost of the actual production of 160 000 pieces =

$$E \frac{160}{180} = \$377 36$$

Then  $H - E$  = Variation due to Production Efficiency (Formula 6)

Applying the above Formula

$$\$377 36 - \$424 53 = -\$47 17$$

That is failure to realize standard production resulted in an increased cost for the superintendent's salary alone of \$47 17

FIG 15 Cost Variation Formula Resulting from Variation in Production Efficiency

Assume that in the month of February the salary of the Superintendent was reduced to \$400 00 per month and that an assistant superintendent was added to the payroll at \$250 00 per month

Let  $A$  = The actual payroll in the month = \$650 00

$B$  = The salaries in the month figured at the standard rates

Superintendent	\$500 00
Assistant	250 00
Total	<hr/> 750 00

Using Formula 1 viz

$$B - A = \text{Variations in Rates}$$

Then

$$\$750 00 - \$650 00 = \$100 00$$

Obviously this \$100 00 represents the reduction in costs resulting from the cut in the superintendent's salary

FIG 16 Cost Variation Formula Resulting from Salary Reductions



Let  $B$  = Actual Salaries paid at standard rate = \$750 00

$C$  = Standard Salaries at standard rate = \$500 00

Then  $C - B$  = Variations due to changes from standard (Formula 7)

APPLYING THE ABOVE FORMULA

$$\$500\ 00 - \$750\ 00 = -\$250\ 00$$

That is the costs have increased \$250 00 owing to the addition to the pay roll of the assistant superintendent

FIG 17 Cost Variation Formula Resulting from Additions to the Pay roll

As in preceding figures

Variation in Total =  $H - A$

Calendar Variations =  $D - C$

Idle Time =  $E - D$

Production Efficiency =  $H - E$

Salaries - Rates =  $B - A$

Salaries - Staff =  $C - B$

COMBINED FORMULAS

$$H - A = (D - C) + (E - D) + (H - E) + (B - A) + (C - B)$$

PROOF OF EQUATION

$$H - A = D - C + E - D + H - E + B - A + C - B$$

FIG 18 Derivation of Combined Cost Variation Formula (Figs 13 to 17)

Variation in Total	Calendar Variation	Idle Time	Production Efficiency	Salary Rates	Salary Staff
$H - A$	$= D - C$	$+ E - D$	$+ H - E$	$+ B - A$	$+ C - B$
\$377 36	\$ 471 70	\$424 53	\$377 36	\$750 00	\$500 00
650 00	500 00	471 70	424 53	650 00	750 00
<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
\$272 64	\$ 28 30	\$ 47 17	\$ 47 17	\$100 00	\$350 00
INCREASE	INCREASE	INCREASE	INCREASE	DECREASE	INCREASE

FIG 19 Application of Combined Formula of Fig 18 (Quantities given in Figs 13 to 17)

Total Actual Cost	\$650 00
Standard Value of Production	377 36
<b>NET INCREASE</b>	<b>\$272 64</b>
<b>ANALYSIS OF ABOVE INCREASE</b>	
Calendar Variation due to short month	\$ 28 30
Idle Time due to 20 hrs shut-down	47 17
Production Efficiency due to failure to realize standard production when operating	47 17
Staff variation due to addition of assistant superintendent on payroll	250 00
<b>Total increases</b>	<b>\$372 64</b>
Rates Variation saving due to reduction in superintendent's salary	\$100 00
<b>NET INCREASE AS ABOVE</b>	<b>\$272 64</b>

FIG 20 Summary and Analysis of Cost Variations Based on I<sub>14</sub>, 19

**COST VARIATION FORMULAS IN DETAIL**—The classification system employed in the table of formulas (Fig 21) showing the working arrangement of the preceding formulas follows:

The capital letters *A* to *H* indicate the elements used in the formulas—*C* for instance indicating the standard cost for the standard month. The small letters *a*, *b*, *c*, etc., indicate the class of expense—*b* for instance indicating a fixed monthly charge such as the salary of a superintendent. The numbers 1 to 14 indicate the various causes of cost variations—number 3 for instance, indicating a cost variation resulting from idle time.

In the classification by formula element

*A* indicates actual time or materials expended figured at the actual rate of pay or price of material.

*B* indicates actual time or materials expended figured at the standard rate of pay or the standard price of material.

*B 1* indicates standard salary for the actual weeks and fractions of a week in the month—it is given by the formula

$$B 1 = \frac{C \text{ (Standard cost for standard month)}}{\text{Number of weeks in standard month}} \times \frac{\text{Actual number of weeks in month}}{\text{Number of weeks in standard month}}$$

Number of weeks in the standard month is computed as follows

Days in year 365

$$\text{Weeks in year} = \frac{365}{7} = 52 \text{ 1428571}$$

Weeks in standard month (1/12th of year)

$$\frac{52 \text{ 1428571}}{12} = 4 \text{ 345238}$$

$B$  1 for the various months is therefore

$$\text{For a 28 day month } B 1 = \frac{C \times 4}{4345238} = C \times .920547948$$

$$\text{For a 30 day month } B 1 = \frac{C \times 4.2/7}{4345238} = C \times .986301325$$

$$\text{For a 31 day month } B 1 = \frac{C \times 4.3/7}{4345238} = C \times 1.019178741$$

$C$  indicates the standard cost for the standard month which in the illustrations has been taken as 212 working hours (see Fig 7)

$D$  indicates the standard cost for the number of standard working hours in the actual month for instance the standard number of working hours for the month of February according to the table of Fig 7 is 200 so that in the month of February  $D$  will equal  $200/212$  of  $C$  which is  $943396 \times C$

$E$  indicates the standard cost for the hours actually worked in the month for instance it has been assumed in the illustration that in the month of February the plant was only operated 180 hours (see Fig 14) so that in this case  $E$  represents  $180/212$  of  $C$  which equals  $849057 \times C$

$H$  indicates the standard cost of the actual production in the month for instance in Fig 15 the standard production per hour has been taken as 1000 pieces so that the standard production in the standard month of 212 hours would be 212 000 pieces. The actual production has been taken as 160 000 pieces so that in this case

$$H \text{ equals } \frac{160000}{212000} \times C \text{ or } 754717 \times C$$

	b	c	d	e	f	g	h
	For a Monthly Charge	Fixed Charge Per Hour	Plant Super Per Hour Worked	Plant Charge Per Week	Direct Expenses	Set Up Item	Charge Varying with Production
1. Net Increase or Decrease	H A	H A	H A	H A	H A	H A	H A
2. Calendar Variations	D C			D B			
3. Idle Time	E D	E D		E D			
4. Production Efficiency	H F	H E	H E	H E			
5. Labor Rate Variations	B A	B A	B A	B A		B A	B A
6. Labor Time Variations	C B	D B	E B	B B			H B
7. Material Prices	C B	B A	B A				B A
8. Material Quantities	C B	D B	E B				H B
9. Variations in No. Set Up						H E	
10. in Set Up Times					H A	E B	
11. On Inclusive Expense							H A
12. Expense - Misc	C A	D A	F A				
13. Salaries - Rates	B A			B A			
14. Salaries - Staff	C B			B B			

FIG 21 Formulas to Apply in the Determination and Analysis of Cost Variations

It will be noted that the table of formulas (Fig 21) provides different formulas to be used in the analysis of cost variations for different classes of expense. The necessity for this is evident when the difference in character of the various classes of expense is considered from the view-

point of cost accounting. For example, a variation in the cost of an expense in the nature of a fixed charge per month (see Figs 13 to 20) may be analyzed into as many as five different causes whereas the cost of the services of a workman paid on an hourly basis and paid only when he is actually working can vary only through the operation of two causes, namely, variations in time and variations in the rate paid per hour (see Figs 9 to 12).

In the classification according to class of expense

- b* indicates an expense which is in the nature of a fixed monthly charge, such as the salary of a superintendent (see Figs 13 to 20)
- c* indicates an expense which is in the nature of a fixed charge per working day as for instance the wages of an employee who works every day of the year except Sundays or holidays regardless of whether or not the plant is operating
- d* indicates an expense which is in the nature of a fixed charge per day worked as for instance the wages of a shop clerk who is paid on an hourly basis and only when the plant is operating
- e* indicates an expense which is in the nature of a fixed charge per week as for instance the salary of a stenographer paid weekly. This class also includes employees paid on an hourly or daily basis and working every day in the year as for instance night watchmen
- f* indicates a distributive expense. The various elements entering into the cost of a distributive expense as power for instance would be classified on the power cost sheet in the same manner as the expenses of a producing department. A weekly salary paid an engineer would be placed in class *e*. On the cost sheets of producing departments which would be charged with a proportion of the power costs distributed from the power cost sheet this power expense would be placed in class *f*
- g* indicates an expense tending to vary directly with the production. In this class come all forms of producing labor and material and supplies consumable in proportion to production

In the classification of cost variations by cause

	Increase or Decrease
1 =	Net
2 =	Because of calendar variations
3 =	" " idle time
4 =	" " production efficiency
5 =	" " labor rate variations
6 =	" " labor time variations
7 =	" " material prices
8 =	" " material consumption
9 =	" " number of set ups
10 =	" " time of material set ups
11 =	" " variations in distributive expenses
12 =	" " variations in miscellaneous expenses
13 =	" " variations in the rates of salary paid
14 =	" " variations in the salaried staff

**ILLUSTRATION OF USE OF A COST FORMULA**—In Figs 13 to 20 is illustrated the method of building up the formula shown on the table of formulas (see Fig 21 covering a class *b* expense, that is a fixed monthly charge) also the manner in which this formula would be used for the purpose of analyzing a cost variation. Attention is particularly drawn to Fig 18 as illustrating the fact that the formulas shown are all simple equations

**COST AND VARIATION ANALYSIS SHEET**—In Fig 22 columns *A* to *H* at the left of the form are provided for recording the various elements used in the formulas, columns 1 to 14 at the right are for the purpose of applying the cost formulas to these elements to obtain an analysis of the variations from standard by cause.

The foundation of the cost and variation sheet analysis is column *C* where are recorded the standard costs for the standard month, in other words the standard costs for the year divided by 12. In the illustration it is assumed that the standard expenses of the press department in the standard month of 212 working hours are as follows:

Producing Payroll	\$3 000 00
Foreman	200 00
Inspector (\$42 a week)	182 40
Annealer (\$63 an hour)	137 80
Shop clerk (\$50 an hour)	106 00
Truckers and sweepers (\$40 an hour)	169 60
Lubricants and supplies	100 00
Miscellaneous maintenance supplies	75 00
General factory expense	141 67
Depreciation	780 00
Power	300 00
Light and heat expense	100 00
Tools	500 00
Total	\$6 792 56

This information is standard and, to avoid the necessity for rewriting it each month the figures should be duplicated or printed on the cost and variation sheets (Fig 22) with the addition of the following figure in a standard price or rate column under the head of 'Actual at Standard' (*B*) all cost formulas in columns under head of "Cost Variation Analysis."

Figures in column *A* are the actual cost figures for the month taken from the payroll stores and burden distribution sheets. Figures in column *B* are the actual hours (or quantity) as shown in column *A* extended at the standard rates (or prices) entered in column *B*.

For instance, in the case of the shop clerk shown in the illustration the charge in the *B* column of \$100 represents the extension of the 200 hours shown in the *A* column at the standard rate per hour of \$0.50 in the *B* column.

Figures in columns *B-1*, *D* and *E* are based on the figures in column *C*. May is a 31 day month and in a 31 day month *B-1* equals 101.9179% of *C*. Therefore this ratio is entered at the head of column *B-1* as shown. In Fig 7 the normal working hours in the month of May have been taken as 218 as compared with the standard working hours in the standard month of 212, accordingly, the figures in column *D* equal 218/212 (or 102.8302%) of the figures in column *C* and this ratio is entered at the head of column *D*. The hours actually worked by the press department have been assumed as 200, so the figures in column *E* represent 200/212 (or 94.3396%) of the figures in column *C* and this ratio is placed at the head of column *E*.

It is assumed that the departmental burden is taken into costs in proportion to the standard producing labor of the department, and further that the standard producing labor of the work done by the press depart-

Department _____		COST AND VARIATION SHEET										MAY 1921	
Account	Rate											Standard	Actual
		A	B	C	D	E	F	G	H	I	J		
Department Hours													
Salaries													
Production Labor													
Formmen													
Inspector													
Assembler													
Shop Clerk													
Truckers & Sweepers													
Lubricants & Supplies													
Mach. Maint. Supplies													
Gravel & Factory Expense													
Depreciation													
Power													
Fluo Space													
Tools													
TOTAL													
Notes and Footing													
Dep. Maint. Cost per hr.													

ment during the month of April was \$2 400 as compared with the standard producing labor of \$3 000 in the standard month and given in column C. The figures in column H therefore, represent  $2,400/3,000$  (or 80%) of the figures in column C and this ratio is entered at the head of column H.

After the ratios have been entered for columns B-1, D, and E as explained above, all that is necessary is to set up these ratios one by one in a calculating machine and multiply them by the items in column C. Short lines are placed in columns B-1, D, and E for those items whose

formulas do not require the use of the figures in these columns, for instance the item of lubricants and supplies is a class *p* expense the formula for which is

$$H - A = (B - A) + (H - B)$$

Obviously, therefore there is no need to make any calculations for columns *B-1*, *D*, and *E* for this item of expense, accordingly short lines are used to indicate that as regards this particular expense no figures need be placed in these columns. These short lines should be duplicated on the cost and variation sheets in the same manner as the figures in column *C* and the cost formulas, as previously mentioned.

**USE OF COST FORMULA ON COST AND VARIATION SHEET**—The item of "Foreman" may be taken for the purpose of illustration. This is a class *b* expense (that is a fixed charge per month) and the formula for this expense according to the table of formulas is

$$H - 1 = (D - C) + (E - D) + (H - E) + (B - A) + (C - B)$$

This formula will be duplicated on the master cost and variation sheet for the press department on the "Foreman" line and in the appropriate cost variation analysis columns as illustrated on Fig. 22.

Applying this cost formula as shown on Fig. 22 gives the following

1 Net Increase or Decrease ( $H - A$ )

$$\begin{array}{r} H \ \$160.00 \\ - 1 \ \underline{225.00} \end{array}$$

Increase      Decrease

\$65.00

2 Calendar Variations ( $D - C$ )

$$\begin{array}{r} D \ \$205.00 \\ - C \ \underline{200.00} \end{array}$$

\$5.00

3 Idle Time ( $E - D$ )

$$\begin{array}{r} E \ \$188.68 \\ - D \ \underline{205.00} \end{array}$$

16.98

4 Production Efficiency ( $H - E$ )

$$\begin{array}{r} H \ \$160.00 \\ - E \ \underline{188.68} \end{array}$$

28.68

11 Salary Rate Variations ( $P - A$ )

$$\begin{array}{r} P \ \$200.00 \\ - 1 \ \underline{225.00} \end{array}$$

25.00

12 Salary Staff Variations ( $C - B$ )

$$\begin{array}{r} C \ \$200.00 \\ - B \ \underline{200.00} \end{array}$$

On the cost and variation sheet, increases in cost (that is, when the actual cost is in excess of standard) are entered in red ink and decreases in black. As formulas are simple equations, it follows that the net of the figures in the cost variation analysis columns must balance with the figures in the net increase or decrease column. This self-balancing feature of the sheet is a material aid to accuracy. The work of computing the cost variation analysis is a purely mechanical operation after the standard data have been filled in so the major portion of the clerical work on these sheets can be handled by ordinary clerical help.

## Profit Variation

**PREDETERMINING PROFITS**—Cost variation formulas are of value only as they assist in reducing costs and consequently in increasing profits. If the fullest value is to be obtained from the use of standards in accounting, it is necessary not only to set standards for manufacturing costs but also, for all other factors affecting profits such as volume of sales, margins of profit, selling and administrative expenses. To be successful, a modern business must plan for its profits in advance instead of using the method of examining its progress or decline at the end of an accounting period.

Predetermination of profits calls for predetermination of sales or setting sales quotas. From the standpoint of sales administration alone, and apart from accounting the advantages resulting from the use of sales quotas are such that many large concerns consider them of supreme importance in obtaining maximum results from the selling organization.

**Causes of Profit Variations**—Where sales are predetermined and conditions render feasible the predetermination of profits the general principles given for the analysis of cost variations apply to the analysis by causes of variations from estimated profits. The analysis should show

Actual Profits for month	\$
Estimated Profits for month	\$
Net Increase or Decrease	\$

### Analysis of above Net Increase or Decrease

1 Variations in Volume of Sales	\$
2 Variations in Sales Prices	\$
3 Variations in Variety	\$
4 Variations in Selling and Administrative Expense	\$
5 Variations in Manufacturing Cost	\$

**Variations in Volume of Sales**—These show the amount of potential profits which failed to materialize because of the failure to realize the estimated sales volume or conversely the additional profit resulting from selling in excess of the estimated volume. To obtain full value from this information it is desirable that sales quotas be set for each selling branch, both in total and for each individual salesman and that a supporting schedule be attached to the summarized profit variation statement providing an analysis by branches and salesmen of the increase or decrease resulting from variations from estimated sales volume.

**Variations in Sales Prices**—These show the extent to which profits have varied from estimates because of variations from the sales prices on which the profit estimates are based. This information fixes responsibility for losses in profits between operating and sales divisions. An analysis of variations in profits resulting from changes from the estimated sales prices should be furnished according to salesmen. This will disclose the common condition (if it exists) where one salesman sells less in dollars than another but earns a larger net profit for the company due to a better price for goods.

**Variations in Variety**—When a manufacturer sells different lines of product on which the ratio of profit varies, any change from estimated relationships of volume of sales of these different lines will result in



variations from estimated profits to the extent of the difference between the margins of profit on the respective lines. This information should be analyzed by sales branches and individual salesmen.

**Variations in Selling and Administrative Expenses**—These variations should be analyzed to distinguish between head office charges and selling and administrative expense of the sales branches.

**Variations in Manufacturing Cost**—Cost and variation analysis sheets referred to on page 93 of this Section, are for product manufactured during the month, not product sold in the month. Using data obtained from the cost and variation sheets as a basis, however, it is easily possible to obtain an analysis of variations in cost of manufacture of the goods sold in the month under a few main heads:

- 1 Fluctuations in the price of raw materials
- 2 Idle time
- 3 Fluctuations in operating costs

### PROFIT VARIATION FORMULAS—

Let  $F$  = Gross profit forecast

$I$  = Net sales—actual

$A$  = Manufacturing cost of goods sold

$M$  = List sales figured at forecasted or standard discounts

$N$  = Standard manufacturing cost of goods sold

$O$  = Standard gross profit on goods sold

$H$  = Standard gross profit on actual list sales divided in accordance with forecasted percentage of sales by lines

$V$  = Actual gross profit

Then, the following formula provides an analysis by causes of variations from estimated or forecasted gross profits:

$$\begin{array}{ccccc} \text{Net} & \text{Variation} & & \text{Variation} & & \text{Variation} & & \text{Variation} \\ \text{Variation} & \text{From Standard} & & \text{from} & & \text{from} & & \text{from} \\ & \text{Manufacturing} & & \text{Standard Sales} & & \text{Standard} & & \text{Standard} \\ & \text{Cost} & & \text{Prices or} & & \text{Variety} & & \text{Sales} \\ & & & \text{Discounts} & & & & \text{Volume} \\ V - F = & N - K & + & I - M & + & O - R & + & R - F \end{array}$$

Example of use of above formula follows:

#### Estimates or Standards

	Line A	Line B	Other Lines	Totals
A List of value of sales	\$68 750 00	\$214 500 00	\$2 406 750 00	\$2 750 000 00
B Net sales % of list	47%	43%	50%	49 33%
C Net sales ( $A \times B$ )	32 321 50	96 525 00	1 238 375 01	1 362 212 50
D Manufacturing cost % of list	26%	27%	26 5%	
E Manufacturing cost amount ( $A \times D$ )	17 875 00	57 915 00	638 683 75	729 478 75
F Gross profit ( $C - D$ )	14 437 50	38 610 00	579 693 25	632 733 75
G Gross profit, % of list ( $E/A$ ) or ( $B - D$ )	21%	18%	23 5%	23 0085%

#### Actual Results for Month

H List sales	\$61 865 00	\$230 000 00	\$2 100 000 00	\$2 391 865 00
I Net sales	27 750 00	105 000 00	1 000 000 00	1 132 750 00
J Manufacturing cost % of list	27 0%	26 0%	25 0%	
K Manufacturing cost amount ( $J \times H$ )	16 703 55	59 800 00	525 000 00	601 503 55
L Gross profit ( $I - K$ )	11 046 45	45 200 00	475 000 00	531 246 45

## Miscellaneous Factors

	Line A	Line B	Other Lines	Totals
M Actual list sales at standard discounts ( $H \times B$ )	\$20 076 55	\$103 500 00	\$1 050 000 00	\$1 187 576 55
N Standard manufacturing cost of goods sold ( $H \times D$ )	10 084 00	02 100 00	550 000 00	034 034 00
O Standard gross profit on goods sold ( $H \times G$ )	12 091 05	41 400 00	493 500 00	547 991 05
P Standard per cent of total sales by lines ( $H/2750 000$ see A above)	2 5%	7 5%	80 7%	100 0%
Q Total actual list sales divided in accordance with standard percentages by lines [ $H(\$2 391 865) \times P$ ]	59 796 63	186 565 47	2 145 502 00	2 391 865 00
R Standard gross profit on actual list sales divided in accordance with standard percentage by lines ( $Q \times G$ )	12 557 20	33 581 78	504 103 18	550 332 25

## GROSS PROFIT VARIATION ANALYSIS

V Actual gross profit	\$11 046 45	\$45 200 00	\$175 000 00	\$331 246 45
W Standard gross profit	14 437 50	38 610 00	579 000 25	632 733 75
Increase or decrease*	3 391 05*	6 590 00	104 000 25*	101 487 30

ANALYSIS OF ABOVE INCREASES OR DECREASES  
BY CAUSES

## Manufacturing Cost

N Standard manufacturing cost of goods sold	\$10 084 00	\$02 100 00	\$550 000 00	\$043 034 00
K Actual manufacturing cost of goods sold	10 703 55	50 800 00	525 000 00	001 503 55
Increase* or decrease	619 55*	2 300 00	31 500 00	33 191 35

## Sales Prices or Discounts

I Net sales	27 750 00	105 000 00	1 000 000 00	1 132 750 00
M List sales figured at standard discounts	20 076 55	103 500 00	1 050 000 00	1 182 576 55
Increase or decrease*	1 396 55*	1 500 00	50 000 00*	40 870 55*

## Sales Variety

O Standard gross profit on sales	12 091 05	41 400 00	493 500 00	547 991 05
R Standard gross profit on actual list sales divided in accordance with standard percentages by lines	12 557 20	33 581 78	504 103 18	550 332 25
Increase or decrease*	466 15	7 815 72	10 603 18*	2 410 60*

## Sales Volume

R See above	12 557 20	33 581 78	504 103 18	550 332 25
T Standard gross profit	14 437 50	38 610 00	579 000 25	632 733 75
Increase or decrease*	1 880 30*	5 028 22*	75 493 07*	82 401 50*
Net increase or decrease* from standard gross profit as above	3 391 05*	6 590 00	104 000 25*	101 487 30*

Summarizing we have the following

	Line A	Line B	Other Lines	All Lines
Actual gross profit	\$11 046 45	\$45 200 00	\$175 000 00	\$331 246 45
Standard gross profit	14 437 50	38 610 00	579 000 25	632 733 75
Increase or decrease*	3 391 05*	6 590 00	104 000 25*	101 487 30*

## Analysis by Causes

	Line A	Line B	Other Lines	All Lines
Manufacturing cost	618 65*	2 300 00	31 500 00	33 181 35
Price or discounts	1 326 05*	1 500 00	50 000 00*	49 826 55*
Variety	434 36	7 818 22	10 653 18*	2 440 96*
Volume	1 880 21*	5 628 22*	7,403 07*	82 401 50*

## Profit Graphs

**PROFIT GRAPH DEFINED**—A different form of analysis of profit variations is through the use of profit graphs. Profits by themselves do not indicate the degree of business efficiency, in fact, they are not significant until expressed in relation to some other factor. They are the result of the interrelationship of certain forces consisting of volume unit selling price and costs and they are also affected by the rapidity of turnover of inventories and capital. It is management's prime function to balance these factors in order to create maximum profits.

A profit graph is a condensed pictorial representation of a master flexible budget showing the normal profit for any given sales volume and any depletion therefrom. According to Stevenson, Jordan and Harrison (*Analyzing the Profit Structure*) the profit graph furnishes a picture of the profit structure which enables an executive to differentiate between the effect of volume changes and the results of price or cost changes upon profits.

**COST BEHAVIOR**—From the standpoint of behavior there are three types of costs:

- 1 Those that have no relationship to volume commonly called **fixed** stand by or **shut down costs**. These are costs of time because they accumulate in a business with the passage of time. Such items as taxes, insurance, executive salaries and depreciation are examples of fixed costs.
- 2 Those that are directly related to volume are called **variable**. These are costs of volume and they increase as volume increases. Direct labor, commissions to salesmen and compensation insurance are examples of variable costs.
- 3 Those that are variable with a fixed portion that exists at zero capacity are called by many names such as **fixed variable**, **semi variable** and **partly variable**. Such profit and loss items as advertising, communication, and power are examples of these costs. The costs vary with volume but not in direct proportion to the change in volume; they can be reduced as volume is reduced but cannot be eliminated entirely when volume is zero.

The terms fixed and variable refer by common consent to total costs. Confusion is created when the terms are applied to unit costs, since in the latter case then meaning would be reversed. As stated by Gardner (*Variable Budget Control*):

In dynamic costs stand by (fixed) costs become variable and variable costs become fixed in relation to the base of activity.

This double image in costs is illustrated in the table on page 101 and in Figs. 23 and 24 based on the table figures.

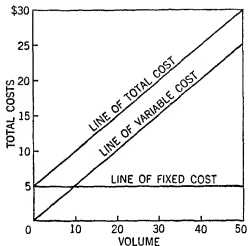


FIG 23 Graph of Total Fixed and Variable Costs

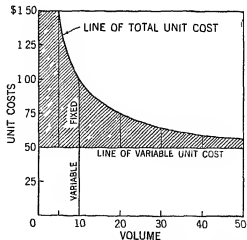


FIG 24 Graph of Fixed and Variable Costs on a Unit Cost Basis

## FIXED AND VARIABLE COSTS

A TOTAL COSTS				B UNIT COSTS		
Number of Units Produced	Variable Cost	Fixed Cost	Total Cost	Variable Cost per Unit	Fixed Cost per Unit	Total Unit Cost
10	5 00	\$5 00	\$10 00	\$ .50	50	\$1 00
20	10 00	5 00	15 00	.50	25	.75
30	15 00	5 00	20 00	.50	167	.667
40	20 00	5 00	25 00	.50	125	.625
50	25 00	5 00	30 00	.50	10	.60

The "A" section of this table demonstrates that the amounts of variable costs are in direct relation to volume produced which varies from 10 to 50 units while the amount of fixed costs remains constant. Section "B" demonstrates that as volume increases the variable cost per unit has become a constant while the fixed cost per unit varies inversely to the increase in volume. Fixed costs are always the same regardless of volume so that when the point of view shifts to unit fixed cost it becomes variable per unit.

Because fixed costs decrease per unit at each volume point but will never reach "0" at either end the line of total cost takes the form of a hyperbolic curve. In Fig. 23 the constant is shown by the line of fixed costs which becomes the line of unit variable cost in Fig. 24. For purposes of the profit graph, however, costs are classified on the total basis as in Fig. 23.

**ANALYZING PARTIALLY FIXED COSTS**—For control purposes the partially fixed costs must be broken up into their fixed and variable components. With the setting of a required profit ratio, a limit is automatically set for costs. By splitting up the partially fixed items, all costs become either fixed or variable and limits may be set for each. A number of methods are in use for making this segregation.

**Knoeppel's Method**—Knoeppel plots the data for each account that is the  $y$  values or costs corresponding to given  $x$  values or sales. He then fits a straight line to these points by the method of least squares. The line is of the type

$$y = mx + b$$

where  $m$  is the slope of the line representing variable expense,  $b$  is the point of intersection on the  $Y$  axis and represents the amount of fixed cost at zero capacity. This method is also used by Stevenson, Jordan & Harrison. It is illustrated in Fig. 25 for indirect labor which is based on the following data:

Period	Indirect Labor	Direct Labor
1	\$ 193	\$ 342
2	207	407
3	221	495
4	237	503
5	277	684
6	234	534
7	228	451
8	279	395
9	198	313
10	175	276
Totals	\$2 209	\$4 450

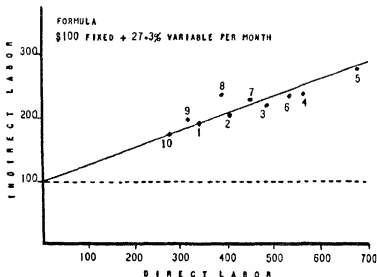


FIG 25 Graphic Analysis of Partly Variable Expense

**Pinkerton's Method**—Pinkerton (Step by Step Approach to Predetermination of Profit at Varying Volumes) also plots the expenses against the sales by months for each item of expense. But instead of using the mathematical technique of Knoeppel he fits a straight line by inspection. The point of intersection on the Y axis represents the fixed portion of the total expense. The procedure then is as follows:

- 1 Read off the monthly fixed portion of that expense.
- 2 Multiply that result by 12 to get the fixed portion of yearly expense.
- 3 Total expense less the result of the second step gives the variable portion.
- 4 Variable portion divided by sales gives the percentage of variable expense.
- 5 Apply the percentage obtained in step 4 to the maximum sales to locate the second point in the diagram. This proves the slope of the line.

As Pinkerton says, "The guide point at the right end of the line is always determined by mathematical calculation after the point of zero sales is determined by eye." A similar diagram is made for each expense so that the results obtained show each item segregated into fixed, fixed plus variable and variable as follows:

Advertising	\$ 750 per month plus	0.268% sales
Taxes	4 800 per month	
Salesmen's commission		0.3423% sales

If each item in the profit and loss statement is expressed as above the total results in an equation of total cost in the same form as Knoeppel's

**Gardner's Method**—Gardner (Variable Budget Control) stresses the importance of selecting a proper base that measures output and to which all costs can be related. He does not automatically use sales as his base as do Knoeppel and Pinkerton. Once the base is established he proceeds along lines similar to Pinkerton's. He plots each month's expense on a simple chart and obtains the "stand-by" or fixed costs by inspection.

Both Gardner and Pinkerton defend their use of a scatter diagram and eye approximation for fixed costs. Pinkerton shows that an error of more than ten dollars in judging the amount of fixed costs produces a difference in the variable portion of no more than fourteen dollars at any sales volume. Gardner says that "stand by is itself a matter of opinion and can be altered with the slightest change of functional thinking on the part of the supervisor." And as to the charting method he says that "this method produces all that could be expected in better control."

**CONSTRUCTION OF PROFIT GRAPH**—The following steps are taken to construct a profit graph:

1. Plot the monthly sales, using per cent of sales capacity for the horizontal axis and dollar volume for the vertical axis. Secure a trend line of sales income by any of the methods discussed earlier.
2. Sales as a straight line can be compared with another straight line representing total costs. This line of total costs is obtained by plotting the fixed and the variable charges then summing equaling the line of total costs. The point where the sales and total cost lines cross is called the break even point (Fig. 26).
3. Eliminating the lines of variable and fixed costs results in a profit graph.
4. The modern profit graph simplifies the above graph further by indicating one line of profit which is simply the difference between the sales and cost lines.

Under this last method the horizontal axis represents the dollar volume of sales instead of per cent of sales capacity. The vertical axis represents dollar income and costs, i.e., profits or losses (Fig. 27), above and below the zero line.

The point of most interest on these graphs is at the intersection of the cost and sales lines as in Fig. 26 or at the point where the profit line cuts the sales volume line as in Fig. 27 and is known as the break even or profitless point. Management is interested in knowing at what percentage of normal sales capacity this break-even point occurs or what dollar value in sales must be maintained to break even at present costs. This information the graph furnishes.

**Mathematical Basis of Profit Graph**—Looking at the graph from a mathematical viewpoint shows it to be simply a graph of two straight lines (sales and total cost) which intersect at some point. Each of these lines has an equation. On rectangular graph paper, the sales income is represented by the equation  $y = x$ , where  $y$  equals sales and  $x$  denotes the plant capacity. The variable expense line can be expressed as  $y = mx$  where  $m$  is the slope of the line or the percentage of variable expenses to sales. The fixed expense is a straight line parallel to the X axis cutting the Y axis at  $b$ , i.e.,  $y = b$ , in other words when  $x$  equals 0 or sales are at 0 capacity, the value of the Y ordinate is  $b$ . The equation for total costs, therefore, is  $y = mx + b$ . Solution of the sales and

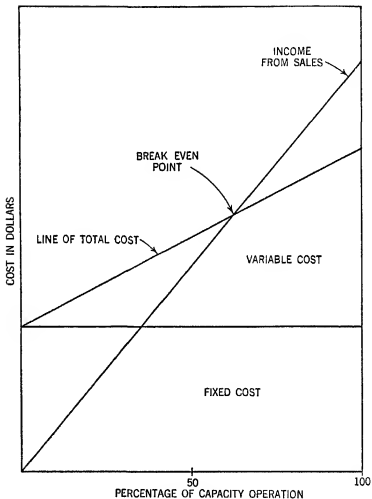


FIG 26 Break Even Chart



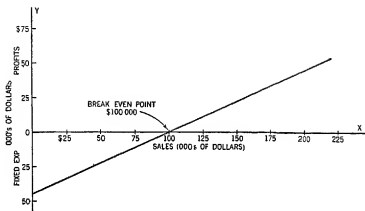


FIG 27 Profit Graph

total cost equations then produces a formula for the profitless point or break even point as follows

$$\begin{array}{ll} \text{Sales equation} & y = x \\ \text{Total cost equation} & y = mx + b \end{array}$$

The business breaks even when  $y$  equals  $y$ . But  $y$  equals  $x$ . Therefore,

$$\begin{aligned} x &= mx + b \\ x - mx &= b \\ x(1 - m) &= b \\ x &= \frac{b}{1 - m} \end{aligned}$$

or

$$x = \frac{\text{Fixed costs}}{1 - \frac{\text{Variable costs}}{\text{Sales}}}$$

The solution of this formula indicates at what sales volume the break-even point is located. Dividing the result by sales at 100% capacity gives the percentage of capacity at which the break-even point is located. For example, assume fixed costs of  $b$  equal \$60,000 and that the percentage of variable costs to sales or  $m$  equals 70%. The break-even point in dollars is

$$\begin{aligned} x &= \frac{\$60,000}{1 - .70} \\ x &= \$200,000 \end{aligned}$$

If 100% capacity sales at normal are \$300,000 then the break-even point as a percentage of sales capacity is found as follows

$$\$200,000 \div \$300,000 = 66\% \text{ of capacity}$$

**Profit-Volume Ratio**—A simplified form of profit graph is described in a monograph of Stevenson, Jordin and Hanson (*Analyzing the Profit Structure*). This graph consists of one line of profit from which profits or losses can be read at varying volumes when costs and prices remain fixed. The horizontal axis measures the dollar volume of sales; the vertical scale the resulting profits or losses. The chart is so drawn that the profit line crosses the X or horizontal axis at the profitless or break-even point. Since at zero sales the variable costs disappear, the losses shown by the chart for sales volumes below (i.e. to the left of) the break-even point are due to the presence of fixed costs.

The slope of the profit line represents the percentage of profit in relation to changes in the dollar volume of sales, in other words the amount of profit added for an increase of \$100 in sales. In the monograph referred to above, the profit line is referred to as the P/V line, and the percentage as the P/V ratio. To illustrate (see Fig. 27)

	Sales	Costs	Profits
April	\$220 000	\$166 000	\$54 000
March	200 000	155 000	45 000
Total change	\$ 20 000	\$ 11 000	\$ 9 000
Change per \$100		\$ 55	\$ 45

The P/V ratio is thus 45%

It is evident that an increase in sales of \$20,000 has produced an increase in profit of \$9,000 or 45% of the change in sales. This change in sales and profits is accompanied by changes in costs. The above tabulation shows an increase of \$11,000 in costs corresponding to an increase of \$20,000 in sales or at the rate of 55%. This is evidently the variable cost. Comparing the variable cost with the total cost above the following analysis results:

	(1) Total Cost	(2) Variable	(3) Fixed
April	\$166 000	\$121 000	\$45 000
March	155 000	110 000	45 000

Multiplying the monthly sales by 55% yields the variable costs. The latter subtracted from the total costs yield the fixed costs.

**Significance of the P/V Ratio**—In effect the P/V ratio measures the margin of profit between the selling price and variable costs, and also determines the slope of the profit graph. Once the P/V ratio is determined, a number of other relationships can then be established.

1 The variable cost is determined by subtracting the P/V ratio from 1 or 100%. Thus if the ratio is 45% as in the example above, the variable cost is 55% of sales.

2 The fixed cost may be determined by subtracting the net profit percentage at the observed level from the P/V ratio. The chart (Fig. 27) shows that at a volume of \$190,000 the profit is \$40,500 or 21.316% of sales. Subtracting this from the P/V ratio of 45% yields 23.684%, representing the fixed charges. By multiplying the sales by this percentage, fixed charges of \$45,000 result which agrees with the prior calculation. Again at sales of \$125,000 the graph shows a profit of \$11,250 or 9% of sales. This yields fixed charges of 45% minus 9% or 36% of sales. Thus, too, gives \$45,000 as the amount of the fixed charges. Note that the

amount of fixed charges is constant and that therefore the percentage with respect to sales changes.

3 Since the fixed charges are easily determined it is possible to use the P/V ratio as an indicator of the **net profit position** of a company at any volume of sales. The P/V ratio when applied to the sales volume obviously yields a figure composed of fixed costs and profits. When the fixed charges are subtracted the profit remains. Thus

$$\begin{array}{rcl}
 (S \times P/V) - F & = & P \\
 \text{where } S & = & \text{Sales} \\
 F & = & \text{Fixed costs} \\
 P & = & \text{Net profit}
 \end{array}$$

For example in Fig. 27 at a sales volume of \$160 000 the equation produces the following results:

$$\begin{array}{rcl}
 (\$160\,000 \times 45\%) - \$45\,000 & = & P \\
 \$72\,000 & - & \$45\,000 = \$27\,000 \text{ Profit}
 \end{array}$$

Or at a volume of \$80 000

$$\begin{array}{rcl}
 (\$80\,000 \times 45\%) - \$45\,000 & = & P \\
 \$36\,000 & - & \$45\,000 = \$9\,000 \text{ Loss}
 \end{array}$$

Thus the equation holds good at any volume. Note also that the variable costs do not appear in the equation and this therefore simplifies the process of profit planning.

4 The P/V ratio may be used to fix the **break-even point**. The point where the P/V line crosses the X axis is called the break-even point. Its position on the chart is found by dividing the total fixed charges by the P/V ratio. In the example already used, the fixed charges are \$45 000. The computation is as follows:

$$\$45\,000 \div 45 = \$100\,000$$

**Improving the P/V Ratio**—There are three ways for improving the ratio:

- 1 Increase prices
- 2 Reduce variable costs with reductions in sales volume
- 3 Change the composition of sales to increase the proportion of those items which carry a higher margin of profit

Concerning the last point Stevenson Jordan and Harrison (Profit on Net Worth) state:

Analysis of sales will disclose large variations in the P/V ratio:

- a Between products, sizes or grades
- b Between territories
- c Between salesmen
- d Between classes of customers
- e Between sizes of accounts in any one customer class

For example, one company found a P/V ratio of 51% for about half of its sales and a P/V ratio of 26% for the remainder resulting in an average of 37% P/V for the total. This produced a profit of 37% on sales. By concentrating its selling effort on products with the higher P/V ratios, the company succeeded in raising the average P/V from 37% to 44% and produced a profit of 107% on sales thereby almost tripling the profit. Note that this improvement was obtained with no increase in any unit price without reducing manufacturing costs and with no change in total sales volume.

**Margin of Safety**—Sales in excess of the break even point represent a margin of safety (M/s) and such excess may be reduced to a percentage of sales. It is affected by

- 1 P/V ratio
- 2 Sales volume
- 3 Fixed expenses

Where the P/V ratio and sales volume are static it may be possible to increase the margin of safety by reducing the fixed charges. The latter has the effect of reducing the break even point (i.e. moving it to the left on the chart) and thus widening the gap between the sales volume and the break even point with a consequent increase in safety margin. In Fig. 27, with sales of \$160 000 the margin of safety is as follows

$$\$60\,000 - \$160\,000 = 37\% \text{ of sales}$$

The size of the safety margin determines to a considerable extent the soundness of the business. A high safety margin reveals that the business can absorb a considerable drop in sales volume before showing a loss.

The profit (*P*) can be expressed as the resultant of the P/V ratio and the margin of safety

$$P = P/V \times M/S$$

If the ratio is 40% and the safety margin 25% then

$$P = 40\% \times 25\% = 10\%$$

**USES OF PROFIT GRAPH**—Profits are the resultant of various forces as follows

- 1 Selling price
- 2 Sales volume
- 3 Costs
  - a Fixed
  - b Variable
- 4 Composition or "mix"

In analyzing profits as well as in planning the profits for the coming period it is necessary to bear in mind the contribution to the profit picture made by each of the above factors. The solution to a poor profit situation may not be an increase in selling price or sales volume but may have to be sought in a decrease in costs or a change in the composition of the sales. Decreased costs definitely affect the location of the break-even point, and thus the profit potential may be increased without any increase in volume.

**Price and Volume**—The effect of a price reduction must be carefully analyzed particularly because of the effect it may have on the additional volume to be secured as a result of the price decline. Assume that sales are 1 000 units per month at \$100. Fixed cost is \$20 000, variable cost is \$80,000, or 80% of sales.

The P/V ratio then is 40%

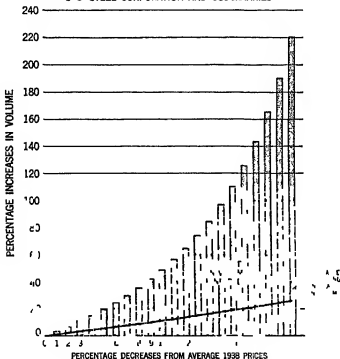
$$\text{Break even point } \$20\,000 \div 40\% = \$50\,000$$

A reduction of 10% in the selling price causes a loss of profit of \$10,000. To compensate for this loss, added sales must be found or costs reduced.

Let *x* = additional units to be sold to maintain the same total profits

$$\text{Sales revenue} - \text{Fixed charges} - \text{Variable charges} = \text{Profit}$$

INCREASES IN VOLUME NEEDED TO COMPENSATE FOR  
VARIOUS DECREASES IN 1938 PRICES  
COMPARED TO PROBABLE RESULTING INCREASES IN VOLUME  
U S STEEL CORPORATION AND SUBSIDIARIES



NOTE: PROBABLE RESULTING INCREASES IN VOLUME BASED ON ASSUMPTION THAT ELASTICITY OF DEMAND EQUALS 1

FIG 28 Increase in Volume Needed to Compensate for Price Decreases

$$\begin{aligned}
 90(1000 + x) - 20,000 - 00(1000 + x) &= 20,000 \\
 30x &= 10,000 \\
 x &= 33\frac{1}{3} \text{ units}
 \end{aligned}$$

Thus a price cut of 10% must in this case be compensated for by an increase of 33 $\frac{1}{3}$ % in volume in order to realize the same profit as before. If the price cut is to be 20% the added volume needed to maintain profits is 100%.

This makes it necessary to study whether on the basis of available information it is possible to create such a volume of additional demand by such a price cut. In turn this requires a knowledge of the behavior of the demand curve for a commodity, that is whether the demand is elastic or inelastic. For example at the hearings before the Temporary National Economic Committee the U. S. Steel Corporation was able to show that the increases in the volume of steel sold which would have been likely to have resulted from decreases in prices would have been but a small fraction of the percentage increases necessary to compensate for the reductions (Fig. 28).

The **elasticity of demand** for a product is measured by the ratio of the relative resulting increase in the volume to the relative decrease in price. According to the testimony at the hearings referred to above both actual business experience and statistical analyses indicate that the elasticity of demand for steel is less than 1. Therefore, cutting prices in half could no more than double the volume of sales. In Fig. 28 the estimate of the increase in volume needed to compensate for a price cut takes into account the effect of the increased volume in reducing the cost per ton.

**Profits and Costs**—By contrast a decrease in either fixed or variable costs automatically lowers the break-even point. In the example (page 108), if fixed costs are reduced to \$18,000, the break-even point is \$45,000 (that is \$18,000 ÷ 40%). By lowering the break-even point the profit area is automatically increased. Thus the profit graph becomes an important tool in controlling plant expenses.

One important use of the profit graph lies in the analysis of the profitability of the various sales components. Their analysis immediately points to the possible need for remedial action as illustrated in the following discussion adapted from Stevenson, Jordan and Harrison (Profit Planning).

	Sales	Fixed Charges and Profit	P/V Ratio
Product line A	\$ 250,000	\$150,000	60%
B	750,000	350,000	47
C	300,000	0	
D	200,000	-50,000	-25%
Totals	<u>\$1,500,000</u>	<u>\$450,000</u>	<u>30%</u>
Fixed charges		300,000	
Net profit		<u>\$150,000</u>	

The over-all or composite graph is presented in Fig. 29. This shows the break-even point at \$1,000,000 of sales (\$300,000 ÷ 30%) and a margin of safety of 33 $\frac{1}{3}$ % (\$500,000 sales above break-even point divided by \$1,500,000). By plotting the data for each product line separately

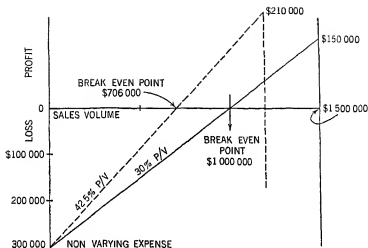


FIG. 29 Total Profit Graph and Average P/V Ratio

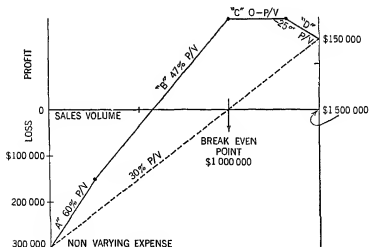


FIG. 30 Profit Graph by Product Lines

Fig. 30 is obtained. This shows graphically the contribution or lack of it made by each product line to the earned profit. The projects below may then be considered as possible remedies.

**Elimination of Unprofitable Product Line**—Other things remaining constant elimination of product line D which was responsible for a loss of \$50 000 raises net profit to \$200 000 and improves the average P/V by raising it from 30% to 38% (ie  $\$300\,000 + \$200\,000 = \$1\,300\,000$ ). The break-even point is moved to about \$790 000. This is computed as follows

$$\$300\,000 - 38\% = \$789\,474$$

**Elimination of Unprofitable Accounts**—In the case under discussion another possibility for improvement lies in the analysis of accounts especially those involving product line C, with the idea of eliminating those whose future activity did not seem likely to make them profitable. As a result sales of \$200 000 of product line C were eliminated leaving \$1 100,000 expected sales.

$$\begin{aligned} \text{New average P/V ratio} \\ (\$300\,000 + \$200\,000) - \$1\,100\,000 &= 45.45\% \\ \text{New break even point} \\ \$300\,000 - 45.45\% &= \$660\,000 \end{aligned}$$

**Increasing Volume**—The elimination of unprofitable lines and accounts releases plant capacity which can then be applied in seeking new profitable lines or accounts. This may involve sales promotion or research development expenses so that at least in the beginning the net profit addition from the new business may not be great. The complete plan as worked out in this example appears as follows

	Sales	Profit Contribution	P/V
Current figures	\$1 500 000	\$150 000	30%
Eliminating product line D	200 000	50 000	
Eliminating unprofitable accounts	200 000	0	
Increasing volume (assumed)	100 000	10 000	
Revised figures	<u>\$1 200 000</u>	<u>\$210 000</u>	<u>42.5%</u>

$$\begin{aligned} \text{P/V ratio} \\ (\$300\,000 + \$210\,000) - \$1\,200\,000 &= 42.5\% \\ \text{Break even point} \\ \$300\,000 - 42.5\% &= \$706\,000 \end{aligned}$$

The chart embodying these changes is shown by the dotted lines in Fig. 29. It presents clearly the effects of controlling the varying elements of prices, costs and volumes. Note particularly that increasing the P/V ratio produces a lowering of the break even point.

**Interrelationship of Price, Volume, and Investment**—Another adaptation of the principles of the profit graph has been made by Paulson (N.A.C.A. Bulletin, vol 23). He makes a graph for a specified dollar investment in cotton gins in a given area of Texas which has been typified by a cost equation representing average costs (fixed and variable) of ginning according to size of gin, type of power and section of state. He recommends the drawing of a single line representing income at a particular selling price per bale of cotton. A series of such lines



would show the income at various selling prices at various outputs or volumes. He then goes further. If the investment were variable another chart results starting at a different point. He suggests superimposing one chart on another. The final chart enables the reader to read off the income at varying prices, at varying volumes, and at varying investments.



## SECTION 3

### COST CLASSIFICATIONS

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## SECTION 3

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### COST CLASSIFICATIONS

#### Capital and Revenue Expenditures

**DEFINITION OF CAPITAL AND REVENUE EXPENDITURES**—Webster's New International Dictionary defines an expenditure as "an outlay, or the creation of a liability, for an asset or an expense item" For accounting purposes expenditures are divided into two major types capital expenditures, and revenue expenditures Hester (Advanced Accounting) defines capital expenditures as "those expenditures which result in charges to some asset account" He describes revenue expenditures as expenditures which "represent all expenses incurred in and for the earning of revenue, and measure its cost" These definitions are amplified by his further statement

Just as the original capital fund, through its expenditure must provide the plant and equipment with which to work so the other expenditures necessary to prepare and market the product must provide the revenue out of which to meet these expenditures and secure a margin of profit else there is encroachment upon the original capital funds

One of the problems of distinguishing between capital and revenue expenditures arises from the practice of dividing the life of a business into arbitrary fiscal and accounting periods and providing financial statements showing operating results for the period and financial standing at the end This makes it essential that the accountant distinguish carefully between expenditures which properly apply against the revenue or income of the current period and expenditures which should be carried forward and applied against the revenue of future periods

**EXPENDITURES RELATING TO FIXED ASSETS**—The problem of distinguishing between capital and revenue expenditures arises most frequently in connection with fixed assets Some expenditures add to the life of assets involved or result in increased capacity or efficiency, while other expenditures are necessary to maintain the assets in efficient working order Differentiation between these two types of expenditure is necessary to determine the correct profit and also the balance sheet value of fixed assets properly applicable against future income In general expenditures connected with fixed assets may be classified under the following headings

- 1 Additions and extensions
- 2 Improvements and betterments
- 3 Replacements
- 4 Repairs and maintenance

Often, a single expenditure may fall partly in one classification and partly in another.

**Additions and extensions** involve an increase of available capacity and can properly be capitalized. They are similar to original expenditure in that capacity and facilities for use in the future are provided. **Improvements and betterments** involve alteration and modernization of existing buildings, equipment, machines and other assets. The emphasis here is on improving rather than adding to or extending an existing asset. In general the cost of such betterments should be capitalized only to the extent that they add to the life of the asset or increase its capacity or speed of production. Himmelblau (*NAC & You Book* 1940) points out the error in capitalizing betterments which do not add to the life of the asset, as follows:

The so-called improvements and betterments seem to pile up at a very rapid rate these days, but when you look at them five or ten years afterwards you can't find anything to show for the expenditures. The major unit has no longer life. You simply improve and improve. At the end of five years you have nothing to show for it except that you see an old asset needing some improvement.

Betterments may or may not be accompanied by **replacements**. The addition of an electric motor to a machine formerly operated by hand is a betterment, probably without any important replacement of parts of the old machine. On the other hand, replacement of a two-ton truck body by a three-ton body is both a replacement and a betterment. In either case, betterment to the extent that the productive capacity of the asset was increased is properly capitalized. In the second case in addition the asset account must be relieved of the cost of the portion of the asset replaced. The term replacement has different meanings:

1 Where a complete plant asset is replaced, the book value of the replaced asset and its related reserve should be written off and the new asset entered on books at cost.

2 Where a portion of building or machine is replaced, the estimated life used in depreciating the asset must be considered:

- a If a relatively long life which contemplates several replacements of parts is in use replacement of these parts serves merely to maintain the asset in efficient usable condition and such expenditures are revenue charges under the head of maintenance.
- b Where the estimated life used for depreciation purposes does not contemplate renewal of parts such renewals may serve to increase the useful life or offset depreciation previously recorded. In such cases to the extent that the estimated life of the asset is extended the expenditure is properly chargeable against either the asset or reserve account.

**Maintenance and repair costs** are revenue expenditures. They are costs of maintaining the plant in efficient working condition without increasing the productive capacity or appreciably extending the life of assets beyond the span contemplated in setting depreciation rates.

#### **CAPITAL EXPENDITURES AS DEFERRED CHARGES—**

In a broad sense, all capital expenditures represent deferred charges to future operations. The amount paid for a machine is a cost applicable to all goods produced on that machine during its life, but this life

period may extend over 20 annual or 240 monthly, fiscal periods. Accordingly, the original cost of a machine is "capitalized," resulting in its display as an asset on the balance sheet, and each year or each month through use of a depreciation reserve, part of this cost is charged against the period's revenue. In somewhat the same way payment of a three-year insurance premium is capitalized by a charge to a "Prepaid Insurance" account but as each period expires the premium applying to that period is charged against revenue by a direct credit to prepaid insurance. In each case the expenditure is capitalized because the greater part of it represents a cost or expense to be applied to periods subsequent to the one in which the expenditure is made.

Paton and Littleton have expressed this concept in their "Introduction to Corporate Accounting Standards" as follows:

The fundamental problem of accounting, therefore, is the division of the stream of costs incurred between the present and the future in the process of measuring future income. The technical instruments used in reporting this division are the income statement and the balance sheet. Both are necessary. The income statement reports the assignment to the current period the balance sheet exhibits the costs incurred which are reasonably applicable to the years to come.

Three classes of expenditures in which the problem of distinguishing between capital and revenue expenditures is most important are

- 1 Organization expenses and carrying charges
- 2 Expenditures in connection with depreciable fixed assets
- 3 Research and development costs

**Organization Expenses and Carrying Charges**—Accounting authorities are generally agreed that costs involved in promoting and organizing a corporation should be capitalized. These costs include state incorporation fees, attorney's fees, cost of securing stock subscriptions, cost of meeting SEC requirements, fees to promoters and organizers, cost of stock certificates and capital stock records, office expenses during organization period and similar expenses. Such expenditures are not costs of current revenue, since little or no revenue is earned during the period of organization. Many of these expenses if incurred later in the life of the corporation would be treated as revenue expenditures.

There is some disagreement among authorities on the proper treatment of the costs of organization once they have been capitalized. The Treasury Department feels that organization expenses represent an asset of continuing value as long as a corporation exists and allows no write-offs against revenue. Kester (Advanced Accounting) agrees to this on theoretical grounds but points out that organization expense because of abuses which have crept in through this channel is an undesirable item on the balance sheet and suggests that it be written off as rapidly as net profits permit. Finney suggests that organization expenses should be written off as rapidly as possible by charges to surplus. Montgomery (Auditing Theory and Practice) prefers to charge off such expenses as incurred and does not favor a write-off over more than a three-year period.

**New Plant and Equipment**—Similar to organization expenses, in that they are incurred prior to the period of income production, are certain

costs connected with the erection of a new plant or building. It is proper to capitalize during the construction period such costs as architect's fees, interest on borrowed money, insurance and taxes, damage strike costs, etc. Once the asset is complete and ready to produce revenue, any costs of this type incurred become chargeable against revenue.

In the construction of plant additions, machinery or equipment by the company itself, the question arises as to the extent to which factory overhead should be included in construction costs, and therefore capitalized. By charging any part of factory overhead to the asset under construction current costs are relieved of such overhead, thus distorting these costs and resulting in a reported profit which is excessive. Where a portion of plant facilities is utilized for construction work without a proportional increase in plant overhead, greater utilization of facilities has resulted in reduced unit costs for overhead. In general, agreement appears to have been reached on the view that overhead may be included in such construction costs, but only to the extent that it has been increased as a result of the construction.

On this point, the following quotation taken from Sanders, Hatfield, and Moore (Statement of Accounting Principles) is pertinent:

In so far as maintenance charges are made against revenue there is little point in charging part of the general overhead to maintenance. But when the maintenance department is also engaged upon new construction to be charged to the property accounts, care must be taken not to charge to the maintenance department any share of general overhead that would ordinarily be charged to cost of property sold.

Some companies have machine shops and other facilities for the manufacture of equipment for their own use. The situation is similar to that shown above for plant additions. Thus according to Sanders, Hatfield and Moore:

When plant assets are constructed by the company itself, the more conservative procedure is to charge to such assets only the direct costs of materials and labor and actual supervision devoted to that work. It is permissible also to allocate to it a reasonable amount of general company overhead, but this should not be done to the extent of relieving the income account of charges which would normally be made against it.

**Research and Development Costs**—Research and development costs raise the same questions of whether the costs are to be deferred, that is capitalized, or whether they are to be written off as revenue charges at the time of their incurrence. Opinion is divided, though more and more research costs are being absorbed in current revenue. (See Section 21 for detailed discussion of this topic.)

## Divisional and Production Cost Classifications

**DIVISIONAL COSTS**—Divisional costs represent the major functions of industrial companies. Hence they are also known as functional costs. Current costs are first arranged according to such functional divisions of a business which usually are



- 1 Production
- 2 Distribution

- 3 Administration
- 4 Finance

**Finance as Major Function**—For accounting purposes there is some question as to whether finance should be listed as a major function of an industrial company. From the viewpoint of a stockholder, interest paid on bonds and notes is a cost of the business and should be deducted from income to determine net profit. But from the viewpoint of a company as an economic unit apart from the stockholders who have provided its equity capital, interest paid is a deduction from operating profit, a payment from the profits of the economic unit to those who provide borrowed capital. Paton has stated this viewpoint (*Advanced Accounting*) as follows:

Interest charges a return on creditor capital, should be treated as a contractual distribution of income rather than as an operating expense. Otherwise the fact of the concern's earning power as an economic entity aside from specific capital structure is obscured, and comparisons between different enterprises and between periods in the same enterprise tend to be improperly made.

The usual practice is to consider interest paid as a nonoperating charge to be deducted on profit and loss statement after operating profit has been determined.

**Administration as Major Function**—Many authorities contend that the primary functions of an industrial company are production and distribution, and that administration is merely a service, a facilitating function. Under this position, costs of administering a business are allocated or apportioned between production and distribution in line with administrative time and effort devoted to each of the two primary functions. A special committee of the National Association of Cost Accountants prepared in 1933 a report dealing among other things with the treatment of administrative expenses (*NAC A Bulletin*, vol. 15). Pros and cons are presented herewith:

**Should Administrative Expenses Be Divided Between Manufacturing and Selling?**

**Affirmative**

- I In a manufacturing business there are no activities which do not serve the principal functions of production and selling.
  - A It is true that general office salaries, expenses incurred in connection with the maintenance of corporate records, legal expenses and other general expenses are not incurred solely for production or solely for selling.
  - B Nevertheless such expenses are brought about by the activity of the organization as a producing and selling unit.
- II In order to obtain the total manufacturing cost and the total selling cost of the product it is essential that administrative expenses be allocated to production and selling.
  - A It is as feasible to make such an allocation as it is to prorate various manufacturing costs between departments or various selling expenses between offices.
  - B Proper inventory valuation requires that administrative costs assignable to manufacturing be included in the unit costs of the product.

- C With prohibition of sales below cost the importance of having the true total cost (compounded from all proper manufacturing and selling elements) should be recognized
- III Where administrative expense is distributed to production and to selling and budgetary control is in operation there is a better incentive, and a wider opportunity, to exercise control over such expenses
  - A When administrative expenses are simply handled as a deduction from the profit on sales there is a tendency to overlook the possibilities of strict control
  - B Control cannot be had without knowledge and information as to the exact effect of administrative expenses on production and on selling is what is needed to point the way to needed efficiencies and economies

#### Negative

- I To attempt to divide administrative expenses between production and selling is to distort the functional relationships of the enterprise
  - A To follow the line of reasoning of the affirmative it might be said with equal logic that the primary purpose of an enterprise is to sell its product and that therefore in the final analysis every cost is a selling cost
  - B As a matter of fact the primary functions of management are three—financing, manufacturing, and selling
    - 1 So called administrative expenses are at least partly concerned with the financial function
    - 2 There is no more justification for charging all such expenses against production and selling than there would be to charge them all against the financial function
- II An effort to prorate administrative expenses between manufacturing and selling would not produce true costs as between departments lines of product, etc
  - A In the absence of really reliable measures of performance (especially where financial function costs are being distributed where they do not belong) it is necessary to use arbitrary methods of distribution for the relationships of administration to manufacturing and selling are far more indirect than are the relationships within the manufacturing section or the selling section
  - B The inclusion of administrative costs in the inventory value runs counter to established principles of inventory valuation
- III It is true that too little attention is paid at times to control over administrative expenses but it does not follow that such expenses must be buried in manufacturing and selling costs in order to have proper control exercised
  - A In fact neither the production executives nor the selling executives are in a position to control administrative expenses
  - B It is the duty of management to control such expenses and this can be better accomplished by having complete information about the relationships of all costs than by combining unrelated costs

**DEFINITION OF TOTAL MANUFACTURING COST**—The joint Committee on Management Terminology has defined total manufacturing cost as follows

Costs to cover the cost of direct material direct labor and factory overhead that is the cost of goods ready for sale and shipment

**OBJECTIVES OF CLASSIFICATION**—In production cost accounting there are two primary objectives

- 1 Determining unit costs of products for use in inventory valuation pricing and profit determination
- 2 Providing data needed for control of costs

In the attainment of these objectives no single classification or group of classifications is equally effective in all cases. For different purposes different kinds of information are required. Hence, costs must be so arranged and classified that computation on various bases become possible. In other words costs must be capable of being combined in different ways to serve different purposes. Note that a classification suitable for one kind of information is not necessarily good for another. The only valid criterion of value of any particular basis of classification or any combination of classifications is a practical one. Does this method give more accurate unit costs or more useful information for cost control purposes than any alternative method?

Once a body of costs has been recognized as production costs the analysis of these costs by detailed classifications and the combining of the details to get unit costs of products and activities is a practical matter of finding the basis of classification and methods of accumulation which give the most accurate unit costs and most useful cost control information. Obviously, this statement needs to be modified by a consideration of clerical costs of possible alternative methods. Thus there is no fundamental principle involved in deciding whether a certain material is direct material cost or part of factory overhead. It is merely a practical matter of deciding which treatment gives more accurate final cost and the most information for control purposes. If a preferred method is most costly there is the further problem of deciding whether the additional accuracy and greater cost control information justify the added clerical costs involved.

**BASES FOR ANALYZING PRODUCTION COSTS**—In the process of classifying costs the accountant makes use of both analysis and synthesis

- 1 Breakdown of the stream of costs into its individual components each labeled in such a way as to permit ready accumulation
- 2 Accumulation of these costs to provide data desired in the form of unit product costs and significant figures for cost control

In the analysis phase of this process, six bases of classification have been found particularly useful

- 1 By nature of item or service acquired
- 2 By costing unit
- 3 By relation to costing unit, i.e. direct or indirect charges for product
- 4 By department process operation or cost center
- 5 By relation to department, i.e. direct or indirect charges to department
- 6 By behavior i.e. tendency to vary with rate of activity

**CLASSIFICATION BY NATURE OF EXPENDITURE**—In the process of analysis the accountant first develops a list of accounts to indicate the nature of each item or service acquired. This may be simple or complex depending on the needs of each case. In one company there may be only one account for insurance, while in another company accounts may be provided for fire insurance, use and occupancy insurance, workmen's compensation insurance, etc.

Alined to this type of analysis is classification by cost elements, namely material, labor, and expense. Each of these may be further subdivided:

1 Direct material	4 Indirect material
2 Direct labor	5 Indirect labor
3 Direct expense	6 Indirect expense

Since indirect expenses are normally applied to products as an entity, it is general practice to combine them under the head of factory overhead or burden.

The Coidage Institute has suggested that for operating or direct departments the following break down of **factory overhead** be observed:

1 Supervision, oilers and clerks	6 Taxes
2 Truckers	7 Insurance—employees' liability
3 Sweepers and cleaners	8 Insurance—fire, etc.
4 Weighers, elevator men	9 Depreciation
5 Supplies	

In addition, a separate classification of costs was suggested for each auxiliary or service department. The National Battery Manufacturers Association has published for use of its members an alphabetical index of indirect manufacturing expenses which is quoted below:

#### Alphabetical Index of Indirect Manufacturing Expense

Item	Account	Item	Account
Accident Compensation	622	Clerks Cost Department (Salaries)	222
Accounting Department (Factory)		Clerks Time (Salaries)	223
Head of	211	Clerks Traffic (Salaries)	223
Acetylene	276	Coal Wages of Employees Unloading	246
Acid (Other than chargeable direct to product)	323	Coal Consumed	313
Allowance for Vacation	624	Compensation Accident	622
Alteration of Finished Product	444	Connectors Lead (For forming)	325
Air and Steam	314	Conveyors Maintenance of	523
Apparel (Such as gloves, aprons, coveralls, etc.)	322	Cost Department Head of (Salary)	211
Appliances and Furniture (Factory)		Cost Department Clerks Salaries of	223
Maintenance of	542	Coveralls	323
Aprons	399	Defective Purchased Materials	443
Automobiles Maintenance of	554	Defective Workmanship	441
Bonus (On nonproductive work)	265	Demurrage	472
Boots	372	Depreciation	611
Brooms	328	Dies Maintenance of	532
Brushes	328	Draftsmen Salaries of	224
Buildings and Structures Maintenance of	511	Driveways Maintenance of	551
Bulbs and Lamps	328	Drying Equipment Maintenance of	572
Burning Rooms Maintenance of	543	Electric Power (Other than chargeable direct to product)	329
Chemicals (Other than acid)	324	Electrical Apparatus Maintenance of	536
Chemists Salaries and Wages of	224	Elevator Operators Wages of	241
Cleaning and Sweeping Wages	247	Elevators Maintenance of	524
		Engineering Department Head of (Salary)	211

## Alphabetical Index of Indirect Manufacturing Expense (Cont'd)

ITEM	Account	ITEM	Account
Engineering Department Employees		Miscellaneous Indirect Labor	266
Other (Salaries)	274	Miscellaneous Operating Supplies	338
Equipment Rearranging	435	Miscellaneous Operating Expense	435
Engineering Department Head of Experimental Department Employees		Mixers Maintenance of	328
Other (Salaries)	224	Motors Maintenance of	327
Factory Accounting Department Head of (Salary)	211	Moulds Maintenance of	331
Factory Clerks Salaries of (Other than time clerks)	223	Nondurable Tools Used	321
Factory Fixtures Maintenance of	541	Oil Fuel (Consumed)	312
Factory Forms (Printing)	264	Oil and Grease Lubricating	398
Factory Time Clerks Salaries of	293	Oiling and Greasing Wages	249
Fences Maintenance of	512	Operating Expense Miscellaneous (Other than provided for)	436
Finger Cots	322	Operating Supplies Miscellaneous (Other than provided for)	328
Fixtures Maintenance of Factory	541	Operating Instructors Wages	963
Foremen and Assistants Salaries of	212	Overalls Used	322
Forming Tools Maintenance of	521	Oxygen	326
Forms, Factory (Printing)	264	Paper Pasting	327
Forms, Burning (Maintenance of)	333	Pasting Machine Maintenance of	326
Fuel Unloading	246	Payroll Department Salary of Head of	211
Fuel Oil Consumed	312	Pensions	625
Furnaces, Maintenance of Melting	538	Piping (Inside) Maintenance of	514
Furniture and Appliances Maintenance of Factory	542	Piping (Outside) Maintenance of	519
Gas Consumed	311	Postage Factory	432
Gas Generating Salaries and Wages	232	Power (Other than chargeable direct to product)	399
Gates Maintenance of	512	Power Transforming or Producing Salaries and Wages	231
Gloves Used	322	Printing (Factory Forms)	264
Greases Lubricating	323	Punch Presses Maintenance of	525
Greasing and Oiling Wages	249	Purchased Materials Defective	442
Grounds Maintenance of	512	Purchasing Department Salary of Head of	211
Group Insurance	623	Rage and Wipers	328
Handling Materials Wages	242	Railway Tracks Maintenance of	552
Heating	325	Rearranging Equipment	435
Hydrogen Used	326	Receiving Department Salary of Head of	212
Idle Time (Not otherwise provided for)	262	Rentals	613
Indirect Labor (Not otherwise provided for)	266	Reworking Finished Product	444
Indirect Manufacturing Departments Salaries of Heads of	211	Roads and Driveways Maintenance of	551
Inspection Wages (Other than included in direct cost)	221	Rolling Stock Maintenance of	553
Instructors Wages of	263	Shipping Department Salary of Foreman of	212
Insurance Compensation	622	Sidewalks Maintenance of	551
Insurance Group	623	Small Tools Used	391
Insurance (Other than compensation or group)	621	Stationary Factory	433
Inventory Wages of employees taking	245	Steam and Heat Generating Salaries and Wages	233
Janitors Wages of	247	Steam and Air	314
Kilns (Dry) Maintenance of	522	Stockkeeping Salary of Foreman	212
Laboratory Salary of Manager of	211	Stockkeeping Employees Other (Wages)	243
Laboratory Employees, Salaries of (Other than manager)	224	Structures and Buildings Maintenance of	511
Laboratory Supplies	329	Superintendents and Assistants Salaries of	211
Lamps and Bulbs	328	Supplies (Not otherwise provided for)	328
Lead Connectors (For forming)	325	Sweeping and Cleaning Wages	247
Losses due to defects (Not otherwise provided for)	443	Tanks (Forming) Maintenance of	521
Machinery Maintenance of (Not otherwise provided for)	528	Taxes	612
Material Handling Wages	242	Telephone and Telegraph (Factory)	494
Melting Furnaces Maintenance of	528	Time Allowed	261

## Alphabetical Index of Indirect Manufacturing Expense (Cont'd)

Item	Account	Item	Account
Time Clerks Salaries of	293	Trucks (Small Factors) Mainte-	
Tools Maintenance of (Other than		nance of	555
small tools)	528	Unloading Fuel Wage	246
Tools Used (Small)	321	Vacation Allowance	094
Trucks (Railway) Maintenance of	332	Watchmen Wages of	248
Tractors (Industrial) Maintenance		Water (Other than chargeable direct	
of	555	to product)	330
Traffic Clerks Salaries of	222	Wearing Apparel	392
Traffic Department Salary of Head		Wipers and Rags	378
of	211	Wiring (Inside) Maintenance of	514
Transportation (Unrecoverable)	421	Wiring (Outside) Maintenance of	513
Traveling Expense Factory	431	Works Manager and Assistants	
Trucks (Industrial) Maintenance of	556	Salaries of	211

This expense classification was built up around the production of storage batteries. A number of the expenses such as boots and hydrogen used, are special to this particular business. Numerous other accounts are standard and serve many businesses. The scope of classification of indirect manufacturing expense depends upon the wishes of management. A break down of these expenses as illustrated serves to control the various items. The proportion or distribution of indirect manufacturing expense is on a standard or fixed basis in most plants.

The National Battery Manufacturers' Association recommends the following form of distribution of indirect manufacturing expense.

While there are many methods of distributing overhead to the cost of the product it is recommended that overhead which has been determined by the foregoing classification of indirect manufacturing expenses be distributed to the costs of the products as follows:

- 1 Determine the capacity of the business or department for the year
- 2 Determine the average or normal output which may be for example 80% of the peak due to seasonal or other fluctuations
- 3 Determine the indirect manufacturing expenses for the year
- 4 Then determine standard or average overhead rates so that all of the indirect manufacturing expenses would be absorbed in the costs when operating at the average output. For example:

If the total overhead (indirect manufacturing expenses) were \$300,000 and estimated annual production is 600,000 units the standard or normal overhead rate would be 50 cents per unit.

- 5 Apply the standard overhead rates for the number of units produced monthly
- 6 Transfer the difference between this and the actual overhead for the month to Profit and Loss account each month and as a final entry of income or expense on the Profit and Loss operating statement dependent on whether it is overabsorbed or underabsorbed by the month's operations.

**COSTING UNITS**—Costing units or cost units are the factors in terms of which costs are expressed. Cost units are related to:

- 1 Product produced
- 2 Selling unit
- 3 Method of production

Trade practice and other factors are considered in making the proper selection. Cost units are by no means uniform. Two companies manufacturing similar products or having similar operations often have different cost units.

**Selection of Cost Units**—Units of measure are usually selected for bulk products. Coal is measured by the ton, gasoline by the gallon, cloth by the yard, paper by the pound, lumber by the foot, and castings by the pound or hundredweight. As distinguished from bulk products, articles such as machines, shoes, pencils, furniture, and automobiles are measured by the unit of one or some multiple of one which includes dozen and gross. With special jobs, the unit is the job itself. These are the bases or units of cost of finished products.

In the fabrication of finished products, other bases are used for various operations. Selection of bases for individual operations offers more problems than selection of bases for finished products.

Under classification of **individual operations** are found plating of all kinds, polishing, enameling, buffing, etc. One company engaged extensively in plating and polishing, after considerable experimenting with cost bases for operations of this type finally decided upon a weighted average method with the use of units. This plan calls for establishing a base known as one unit. The base includes size of the piece, weight of the plating, difficulties encountered because of shape, etc. Each piece handled in production is assigned a unit value. To illustrate for copper plating:

Part No	Units
10265	4
11674	10
7432	6
9610	2

If these four parts were going through production at one time for copper plating, the following table would represent the basis for allocating cost:

Part No	Quantity	Units	Total Units
10265	4 000	4	16 000
11674	1 000	10	10 000
7432	6 000	6	36 000
9610	10 000	2	20 000
			<u>82 000</u>

Part No 10265 would stand 16/82 of the total cost. Each of the other parts would stand a proportionate share. In a plating operation involving many different parts this method has saved time and has been found to be a fair method of cost distribution.

Obviously, use of the **unit method** for determination of plating costs is applicable only where production is more or less standard and continuous. A company doing plating work for customers uses the job order plan for determination of cost. Each job is treated as a distinct unit. In this company all costs are collected for the job. In determining material costs, anodes are weighed at beginning of the month and at the end of the month. The depletion is treated as a direct material cost. Cost is allocated to the various jobs handled during the month by the foreman who has a record of number of pieces, weight, and thickness of plating. This company reports that satisfactory results are secured from this method of costing.

A third company engaged in large volume production of uniform products treats plating as an operation cost. Because of the uniformity of

product, no distinction is made between size and weight of pieces. This company uses complete cost records and operates on a standard burden basis. The cost executive reports that anodes were first charged to burden. This procedure was then changed and anodes were charged to direct material. Another change was made and anodes were again charged to burden when withdrawn from stock. It is not considered practicable to inventory anodes in this company. With the use of standard burden charges, excess costs of anodes for any one month are eliminated, and depletion equalized over the year.

A fourth company that does considerable plating of small parts, practically uniform as to size, uses the hour as the basis of cost. A record is kept of materials charged into the plating operation. Labor of the plating department is totaled, and departmental burden and general burden rates are used. A record of productive hours is maintained and a productive hour cost determined quarterly. Variations are charged direct to profit and loss. To illustrate:

Plating Department	
Material costs, including anodes	\$ 1 200
Labor	12 000
Burden	3 000
Productive hours	600
Productive Hour Costs	
Materials	\$ 2
Labor	20
Burden	5
Total	<u>\$ 27</u>

For the first 4 hours, three different jobs are placed in process as follows:

Job No		Total Pieces
1	200 pieces $\times$ 2 hours equals	400
2	400 $\times$ 1 "	400
3	600 $\times$ 4 "	2 400
4	400 $\times$ 3 " "	1 200

Total production hour cost for 4 hours is \$108. This is allocated as follows:

Job No	No. of Pieces	Production Cost	Cost Per Piece
1	200	\$ 0 82	\$ 0 491
2	400	0 82	0 491
3	600	58 90	0 981
4	400	29 46	0 736

The fact that bases of costs differ widely is evident from review of the four companies cited. Principles applicable to plating costs may be adapted to operations of a similar nature. Small companies invariably charge plating costs to burden when plating operations are incidental to production. Cost of operations of this type are frequently disposed of in easiest way because of lack of knowledge of specific treatment.

A company performing a soldering operation found it possible to save considerable money by placing this operation in a direct cost



classification in place of a burden classification. A weight basis brought to light noticeable variations in consumption of solder.

Annealing, heat-treating, and the like are handled on a weight basis when sufficient material is used to warrant distinction between pieces. Enameling of small parts is handled on a surface area basis, giving effect to number and weight of coats. In this operation, a "Christmas tree" or small parts holder is used. For large parts, enameling is handled with the use of a conveyor which will include baking of enamel. Basis of cost is surface area and weight of coats.

Porcelain operations call for a surface area basis. Square inches and number of coats are determining factors in allocating costs. Painting and varnishing operations are based on surface area, coordinated with a knowledge of method of application.

A warning is issued that plating, heat treating, enameling, porcelain application, painting show excess costs unless carefully controlled. Testing at frequent intervals is accepted practice for cost control in operations of this nature.

Tinning operations, according to four manufacturers engaged extensively in this work, are handled on a weight basis for steel products. In case of bronze or copper products a surface area basis is used. Bronze and copper products frequently weigh less after tinning operations. Loss in weight is attributed to effect of the metal being placed in molten tin. Steel products after acid dip or pickling process are weighed before the tinning operation and weighed again after the tinning operation. Allowing a percentage for waste, the tin consumed is charged as material. The customary practice is to make a test, weigh a selected number of pieces out of each lot and apply the average to the total number of pieces. Materials used for pickling and flux are charged to burden. Labor for pickling is treated as direct labor.

A classification by costing units is provided in order that costs once classified may later be assembled to provide cost of individual units of products, groups of units (job or process costs) or classes of units (class costs). Product cost units for a wide selection of operations and industries are given below.

#### Cost Units for Representative Industries

Product or Operation	Industry	Basis
Acid phosphate	Fertilizer	Pound or ton
Adding machines	Office appliance	1 unit (special)
		100 units
Alloy melted	Brass foundry	Pound
Apricots	Dried fruit	30 lb cases— (sales weight)
Automobiles	Automobile	1 or 100 units
Automotive parts	Automotive parts	100 units
Barrels	Cooperage	100 units
Batch materials	Glass container	Cwt finished ware
Battery parts	Battery manufacturing	100 units
Batteries wet	Battery manufacturing	100 units
Beet sugar	Sugar	100 lbs (1 bag)
Bolts	Screw machine	100 pieces
Bookkeeping machines	Office appliance	1 unit (special)
		100 units
Bricks	Face brick	1,000 units
Burned ware	Clay products	Units completed

Cost Units for Representative Industries (*Cont d*)

PRODUCT OR OPERATION	INDUSTRY	BASIS
Calculating machines	Office appliance	100 units
Car wheels	Chilled car wheel	100 lbs
Castings	Various foundries	Pound or unit
Cement	Cement	Ton (raw mill)
		Barrel (clinker burning)
		Paper or cloth sacks (sales unit)
Chemicals	Chemical	Gallon
Cleaning	Stove	Pound
Cold cream	Pharmaceutical	Jar or tube
Core making	Grey iron foundry	Job (special)
		Unit (standard)
Core making	Stove	100 pieces
Cosmetics	Pharmaceutical	Gram
Cough drops	Pharmaceutical	Gram
Cutters	Printing	Units and sheets
Flour	Milling	Gram and bushel
		98 lb sacks
		190 lb barrels
Folding	Printing	Units and sheets
Forged brass parts	Pressed metal stamping	100 pieces
Forged steel parts	Pressed metal stamping	100 pieces
Freight car loading	Various	Pound or unit
		Package or car
Furniture	Furniture	Each article
Grapes	Dried fruit	100 lb boxes
		100 lb bags
Hollow tile	Clay products	Ton
Kegs	Cooperage	1 000 bd ft
Lumber	Woodworking	1 000 bd ft
Machine parts	Screw machines	100 pieces
Melting	Gold plating	Ounce
Melting	Grey iron foundry	Pound
Melting	Stove	Pound
Mine clay	Clay products	Ton
		Pound (bulk)
Molding	Stove	100 pieces
Mouth washes	Pharmaceutical	Gallon
Nickel plating	Various	Unit based on surface area
Nuts	Various	Pieces
Painting, advertising signs	Advertising	Job order
Patterns	Stove	Single unit
Pills	Pharmaceutical	Per 1 000
Piston rings	Automotive	1 000 pieces
Presses	Printing	Units and impressions
Pressing	Gold plating	Shell
Processed fabric	Rubber tire	100 sq yds
Prunes	Dried fruit	Pound (sales weight)
Raisins	Dried fruit	25 lb cases
Rubber	Rubber tire	Pound or area (cords unit)
Ruling	Printing	Units and sheets
Salt	Salt mining and refining	Ton and 280 lb barrels
		25 to 70 lb sacks
		71 to 200 lb sacks
		1 to 10 lb packets
Screws	Screw machine	100 pieces
Sheet brass parts	Pressed metal stamping	100 pieces
Sheet steel parts	Pressed metal stamping	100 pieces

Cost Units for Representative Industries (*Cont'd*)

PRODUCT OR OPERATION	INDUSTRY	BASE
Sheetings	Cotton textile	1 pound or yard
Slug cutting machines	Printing	Lin.—unit of 6 mm
Spings	Various	100 pieces
Stamping	Stove	100 piece
Stampings	Automotive parts	100 units
Stampings	Gold plating	Ingot
Sugar beets	Sugar	Ton
Sulphuric acid	Fertilizer	Pound and ton
Swaging	Gold plating	Ingot
Tablets	Pharmaceutical	Per 1 000
Tappets	Automotive	1 000 pieces
Tinning	Various	Weight basis
Tires	Rubber tire	Per tire
Tire casings	Rubber	100 casings
Tooth paste	Pharmaceutical	1 pound (bulk) Tube (unit)
Vacuum cleaners	Vacuum cleaner	100 pieces
Valves	Various	1 000 pieces
Wood parts	Various	Production in rough mill Production in finished mill
Yarns	Cotton textile	Pound and yard

**Cost Units in Relation to Product Costs**—One of the primary objectives of cost accounting is the determination of unit product costs, however the product unit is not always used as a cost unit. Unit costs are in practically all cases average costs. Costs are accumulated by jobs and processes (or operations) and the accumulated costs thus obtained spread over the units produced.

Under the job method of cost accumulation the cost of producing a job or lot is accumulated on a job order and posted to a cost sheet. Material and labor are charged directly to the job. To the prime cost (direct labor plus direct material) is added factory overhead, usually by application of predetermined rates to some production factor. By dividing the total job cost thus obtained by number of units produced an average unit cost is arrived at. If defective material, poor workmanship or some other influence results in the production of 80 units when 100 should have resulted the effect is to increase the unit cost of the product by 25%. The excess cost due to this loss cannot properly be considered an added cost of the job only, it is a loss which should be spread over all production. The only method developed to handle this sort of situation under the job lot method of costing is to divide the total cost of the job by the total of both good and defective units, and to treat the costs of the defective units (after deducting any scrap value) as an overhead item to be prorated over all production. Where this method is followed, such costs of spoiled work should be included in the overhead of the department responsible for spoilage, if responsibility can be assigned to a production department.

Under the process method of costing, all costs for a process for a week, month or other process period are accumulated on a process cost sheet, and divided by the production for the period to obtain unit costs. Under such a costing plan, all units resulting from a process during the month have the same average cost, nothing is accomplished by relieving the cost sheet of the cost of spoiled work and then adding it again as additional overhead.

For cost accounting purposes, the distinction between direct and indirect costs is more important under the job lot method of costing than under process method. When costs are accumulated on a process basis all costs of a process, both direct and indirect, are combined to give the total cost of the process during an accounting period. It does not greatly matter whether a particular material or labor cost is treated as direct or indirect unless the overhead is applied through use of a standard or normal rate. Under a job lot method of costing, on the other hand, direct costs are applied to a specific job and indirect costs, either through use of an actual or standard overhead, are spread over all jobs worked on during period. Failure to treat direct costs as such under this type of costing results in relieving the job of direct costs applicable to it and spreading these costs over all jobs in process during period.

Relatively few products are manufactured by a single operation or the use of a single process. The method used to arrive at unit product costs where the process plan of cost accumulation is used, is illustrated in the manufacture of cement and in the milling of flour, where production flows from one operation or process to the next. If it were not for the accumulation of inventories at the end of certain processes and variations in quantities of these inventories at different times, the average unit costs might be secured by discrediting processes and simply dividing the total factory cost by total units produced. However, because of the variable output of each process, it is necessary to compute a unit cost at the end of each process. This unit cost multiplied by units entering the next process constitutes the material cost of the next process.

**DEFINITION OF COST CENTERS**—In determining production costs, an outstanding prerequisite is to divide the organization into units. Most organizations are divided into departments for administrative purposes. Administrative divisions do not always suffice for the determination of costs. The units of organization outlined for cost purposes are known as cost centers.

**Selecting Cost Centers**—The basis for setting up a cost center is grouping of machines, methods, processes, operations, and the like so as to segregate work activities having a common interest. Expressed in other words, a cost center is a natural division of an organization for cost finding purposes. Cost centers are established to charge direct expenses, such as materials and direct labor, and to distribute burden. Departments rendering service are established as cost centers. The expense of the service departments is apportioned on some selected basis to the production costs. This distribution of service department expense is made through the productive cost centers established.

The Priced Metal Institute, after making a study of cost centers, reported to its members:

We are interested in the division of the plant into units for the segregation of processes and for the collection of expense items. Such units we prefer to designate as burden centers or as centers. In dividing a plant into burden centers there are two kinds: productive or direct burden centers and nonproductive or indirect burden centers.

A productive burden center is one set up to segregate certain equipment into a group, and to collect the expense items in connection therewith in

order that the product operated on that equipment can be charged with the proper burden.

An expense burden center is one set up (sometimes only on paper) to group items of expense in connection with a particular activity, which of itself, is not a productive activity.

A plant should be divided into as many burden centers, productive and expense, as are needed to determine, collect, and distribute the overhead expense and apply it to the product.

In departmentalizing a plant for the purpose of applying burden against the product, careful consideration should be given to the methods by which it can best be done under varying circumstances of manufacture and kinds of operations. Burden centers should be so set up that the burden expense in each is absorbed in the cost of the product on that basis which so far as practicable, most accurately charges such expense.

**Specimen Cost Centers**—In a company producing forgings the cost centers are

Material handling including shearing

Hammers—hot or cold trim

Grinding—if necessary

Press

Inspection—hot inspected as work comes off hammers

The Glass Container Association recommends the following cost centers

Power plant

Steam plant

Gas producer plant

Mold shop

Repair and maintenance department (machine shop)

Raw materials storage and mixing

Melting or tank

Automatic machines or hand centers

Direct machine or hand labor

Blowing room

Lehrs

Selecting

Finished stock storage

**RELATION OF EXPENSES TO DEPARTMENTS**—For cost control purposes a distinction must be made between those costs which are a direct charge against a department and those which are indirect. Probably most factory overhead costs which are indirect with respect to a job or product are, nevertheless, direct costs of individual departments and can be charged to departments without allocation. On the other hand, the indirect costs of a productive department consist largely of apportioned costs of service departments. These same costs, however, constitute direct costs to the service departments.

Thus, whether some expenses are to be considered as direct or indirect charges depends almost entirely on the point of view. When primary manufacturing expenses are being distributed to departments, they constitute direct charges to the indicated departments. But when the service department totals are redistributed to the other departments, the items which were direct charges to the service departments become indirect charges when viewed from the standpoint of the producing department to which the redistributions are carried.

There is no standard practice for treating these items. Each plant develops its own methods of distribution. Where these services are purchased from outside sources, the cost is distributed on a metered basis. Otherwise they must be distributed on some equitable basis. (See Section 18 on Overhead Distribution.)

Cost control is preferably based on control at the source, accordingly a department foreman is held responsible only for those costs which are direct with respect to his department. Any indirect costs which are charged to his department through apportionment or proration are considered the responsibility of the foreman of the service department to which they were originally charged as direct costs. Thus the cost of fuel for providing steam is an indirect cost from viewpoint of products and jobs and of productive departments which use steam, but for the power plant, which is a service department, it is a direct cost.

The Pressed Metal Institute in its Uniform Cost Manual suggests the following nonproductive or indirect burden centers or departments, with costs covered by each and suggested method of disposition:

Nonproductive or indirect burden centers should be established so that each class or kind of nonproductive labor and expense can be segregated and then distributed over other centers and/or absorbed as its nature may require. In most cases the expense center will be identified with and include floor area occupied, although its activities may extend beyond that area.

The following includes expense burden centers of stamping plant to, whether with a general indication of what each covers and the basis of absorption of the expense.

#### Nonproductive or Indirect Burden Centers

NAME	INCLUDES	DISTRIBUTE
Power Plant	Cost of producing electric current	To centers by factor which is product of hp demand by estimated hours operation
Steam Plant	Cost of operating steam plant	To centers using same on basis of use
Water System	Cost of pumping and distributing water	To centers using same on basis of use
Acid System	Cost of operating same and acid itself	To centers using same (Usually a part of pickling center)
Naphtha System	Cost of operating same and naphtha itself	To centers using same (Usually a part of cleaning or painting center)
Fuel Oil System	Cost of operating same and fuel oil itself	To center using same (An heating heat treating die room). On basis of jet capacity by hours of use
Compressed Air	Cost of operating same	To centers using same. On basis of use.
Building Service Expense	Cost of heating, lighting janitor watchmen service elevator service, and water for service use	To centers on basis of adjusted square foot area
General Factory Expense	The general expense center also to this center are closed those centers which are distributable on a total man hour basis	Over other centers on basis of total man hours

Nonproductive or Indirect Burden Centers (*Cont'd*)

NAME	INCLUDES	DISBURSMENT
Employment	Cost of same	General factory expense
Welfare and Safety		
Hospital	Cost of same	General factory expense
Cost and Time		
keeping	Cost of same	General factory expense
Production Department (Scheduling)	Cost of same	Productive man hour basis
Purchasing	Cost of same	Administrative expense
Engineering (Drafting on product and dies for tool room)	Cost of same	To tool room burden
Estimating and Engineering (Drafting) for Sales Department	Cost of same	Selling expense
Die Storage	Cost in connection with storing and handling dies	To press centers on a factor which is the product of the equipment value and estimated running hours
Inspection	That portion which is not absorbed by burden rate	(See note below) Productive man hour basis
Intershop Trucking	Cost of handling materials throughout the shop from first operation to shipping department	Service basis
Packing and Shipping	Cost of same (not including special packages)	Weight basis
Scrap Handling	Cost of collecting cutting and loading scrap	Credited with amount received for scrap and net amount credited to miscellaneous income account
Auto Trucks	Cost of operating same	Receiving and shipping
Experimental Research on Present Products	Cost of same	General factory expenses
Development New Products	Cost of same	Selling expense
Department Rearrangement	Cost of same	To other centers on equipment value basis
Unused Space and Equipment	Charges on space definitely unused and on equipment stacked up or set aside	Miscellaneous charge to P & L
Fixed Charges		
Main Office	Cost of same	Administration and selling expense

Some plants prefer to handle general inspection as an indirect center (or a combination direct and indirect center) and spread that portion which is not absorbed by the burden rate over all productive man hours.

**EXPENSE BEHAVIOR**—The relation of costs to changes in the volume of production or rate of activity is conditioned on the behavior of different cost elements. For control purposes costs are classified as fixed, variable, and semi-variable. This classification is essential in determining allowable costs for cost control purposes, and also in setting rates for the application of overhead.

Fixed costs do not vary in total amount with changes in rate of production. Depreciation, insurance, and taxes are normally fixed costs.

Variable costs tend to vary directly in total amount with variations in the rate of production. Workmen's compensation insurance and royalties based on volume of production are of this type. Doubling the rate of production normally results in doubling the cost.

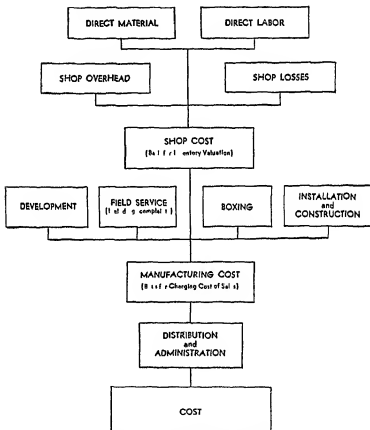


FIG 1 Diagram of Elements of Cost



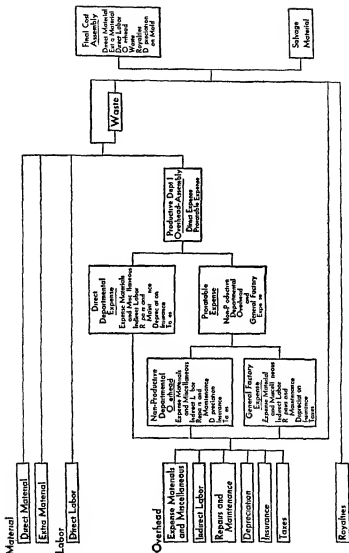


Fig 2 Chart of Factory Cost

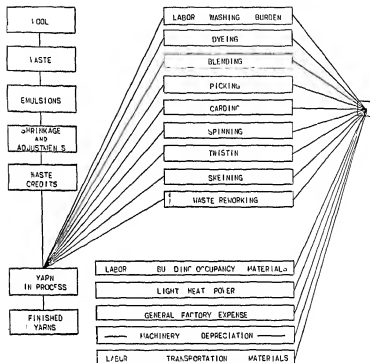


FIG 3 Elements of Cost in Process Industry

In addition there are **semi variable** costs which vary in total amount with variations in volume of production, but not at the same rate. The cost of repairs and maintenance is usually considered semi-variable. A 50% increase in production may produce only a 30% increase in maintenance costs. Semi-variable items are really combinations of fixed and variable items, and through careful study it is possible to separate them and determine separately the amount of fixed cost and the rate of variation of variable element.

#### ADAPTATION OF CLASSIFICATIONS TO INDUSTRY —

Each industry has its own problems in classifying and accumulating costs. Considerable progress has been made in securing general industry agreement on classification of major items of costs through **uniform** accounting activities of trade associations. As an aid to visualizing the relationship between various cost elements several manuals developed

by trade associations have contained diagrams or charts. Three of these are reproduced here as Figs 1 2 and 3.

Fig 1 is a diagram of elements of cost from the Uniform Accounting Manual of the Electrical Manufacturing Industry. Of particular interest in this diagram is the distinction between shop cost (basis for inventory valuation) and manufacturing cost (basis for charging cost of sales). Development costs, field service, boxing and installation and construction are not considered proper for inclusion in inventory values but are treated as additions to cost of sales. The other item of interest on this form is the inclusion of "shop losses" as a separate item of shop cost.

The chart of factory cost from the Uniform Accounting Manual prepared by the Rubber Manufacturers' Association (Fig 2) is of particular interest because it shows successive stages in the accumulation, distribution and application of overhead. Beginning with the primary overhead classification, the chart shows how these costs are distributed to direct departments, nonproductive departments, and a miscellaneous indirect group, general factory expense. Next the prorated portion of nonproductive departmental overhead and general factory expense is combined with direct departmental expense to give productive departmental overhead-assembly, which is applied with direct costs to the individual job or product. Other features of this chart are indications of the direct application of extra materials and royalties.

In both industries considered above costs are accumulated primarily on a job cost basis. Fig 3, from the Cost Manual issued by the Institute of Carpet Manufacturers of America, Inc., illustrates how costs are accumulated in a process type industry. There labor and burden are accumulated by departments. Direct material costs are kept separately, and the other costs applied on the basis of departmental rates.

## Distribution Cost Classifications

**DEFINITION OF DISTRIBUTION COSTS**—Expenses incurred in the distribution of a product are termed distribution costs or selling expenses. Accounting Terminology defines selling expenses:

All expenses incurred in selling, such as salesmen's salaries, commissions and expenses, advertising selling department salaries and expenses samples etc.

While selling expenses have no direct relation to manufacturing costs, the principles of cost determination are fast taking root in this branch of business. Distribution costs are receiving the attention of management.

**OBJECTIVES OF DISTRIBUTION COSTS**—In production cost accounting, the primary objects are

1. Ascertainment of unit product costs
2. Provision of data for cost control

In the case of distribution costs there is no single unit which serves the same purpose as the unit of product does for production costing. As a result a type of costing usually described as distribution cost analysis has developed in the distribution cost field in place of routine

or continuous cost accounting as found in a factory. Procedures have been developed for classification or identification of costs in such a way that they may be analyzed, as occasion demands on any one of a number of bases. Such analyses may provide for determination of costs by territories, by commodities or lines of commodities, by channels of distribution, by classes of customers by size of order and on various other bases. By relating costs as thus classified to some unit of measurement unit distribution costs are developed. Thus unit cost of distribution per sales dollar might be calculated for various territories various methods of sale, various customers etc. Obviously costing on these several bases cannot be carried on as a continuous function but costs can be so classified and labeled at the time of their incurrence that the various analyses can be made as needed.

Distribution cost analysis provides management with information needed for intelligent direction of effort in the sales field, that is it furnishes a basis for control of distribution costs.

**BASES OF CLASSIFICATION**—For cost control and analysis purposes distribution costs are most commonly classified on the following bases:

- 1 By nature of cost item or object of expenditure commonly called primary account basis
- 2 By function performed commonly called functional basis
- 3 By sales territory product group, method of sales etc. sometimes called manner of application basis

This last group may be extended indefinitely and is limited only by the many variable factors which differentiate each sale from every other sale. Heckert (The Analysis and Control of Distribution Costs) suggests the following as bases most frequently needed:

- 1 By territories for example districts branch areas, salesmen's territories trade centers states counties or cities
- 2 By commodities for example, individual commodities or related groups of commodities
- 3 By channels of distribution for example, to wholesalers retailers or ultimate consumers
- 4 By method of sale for example through salesmen mail order company stores house to house solicitation and so forth
- 5 By classes of customers for example, customers with large and small annual purchases
- 6 By size of orders for example the cost applied to securing, handling and filling orders of varying size measured in money
- 7 By organization and operating divisions for example branches departments stores etc
- 8 By salesmen that is the cost applied to the work of individual salesmen or groups of salesmen
- 9 By method of delivery for example, over the counter delivery on request store door delivery peddler trucks etc
- 10 By size or number of physical units for example full and broken cases gross and fractions of a gross, carload and less than carload lots etc
- 11 By terms of sale for example, cash, short term credit, instalment etc

Rertell (NACA Bulletin, vol 20) suggests the following five fields of distribution costs:

- 1 Territorial or geographical areas in which the product is sold
- 2 Types of sales outlets such as retailers jobbers distributors chain, and mail order
- 3 Nature and type of advertising that is required by the different territories and outlets
- 4 Difference in selling methods and costs
- 5 Difference in delivery methods and costs

This means that to determine the cost of a sale it is necessary to analyze costs on each of the five bases suggested by Reitell and then to select the applicable costs and apply them to this specific sale

**PRIMARY ACCOUNT CLASSIFICATIONS**—Two methods are available in developing distribution cost classifications

- 1 Primary classifications are laid out without regard for the functional divisions all primary classes involve all functions and are organized in one all inclusive list functional breakdown is prepared later
- 2 Primary classifications are developed as subdivisions of functional classifications

An illustration of a classification by primary accounts is given below It represents the **commercial expense** classification from the Uniform Accounting Manual for the Rubber Manufacturing Industry Note that this list contains all commercial expenses, i.e., administrative as well as distribution

**Commercial Expense Classification—Rubber Manufacturing Industry**

- 10 Salaries, Wages, and Commissions (Employee Compensation)
  - 101 Salaries
  - 102 Wages
  - 103 Commissions and Additional Compensation
- 11 Commissions—Agents, Brokers Dealers
  - 111 Agents
  - 112 Brokers
  - 113 Dealers' Warehouse
- 12 Traveling and Entertainment Expense
- 13 Rent
  - 131 Space Rental
  - 132 Office Equipment Rental
  - 133 Amortization of Leasehold Improvements
  - 134 Losses on Leases
- 14 Maintenance and Repairs
- 15 Taxes
  - 151 Taxes on Real Estate
  - 152 Taxes on Personal Property
    - 1521 Furniture and Fixtures
    - 1522 Merchandise
    - 1523 Intangibles (Money and Credit)
  - 153 Taxes on Automobiles and Trucks
  - 154 Old Age Benefit Tax
  - 155 Unemployment Insurance Tax
  - 156 Capital Stock Tax (Federal)
  - 157 State Franchise or Income Taxes

Commercial Expense Classification—Rubber Manufacturing Industry—  
(Cont'd)

- 16 Insurance
  - 161 Insurance on Real Estate
    - 1611 Buildings and Appurtenances
    - 1612 Public Liability
    - 1613 Elevator
    - 1614 Riot and Civil Commotion
    - 1615 Pressure Vessel Explosion
  - 162 Insurance on Personal Property
    - 1621 Furniture and Fixtures
    - 1622 Merchandise
    - 1623 Other
      - 16231 Receivables
      - 16232 Use and Occupancy
      - 16233 Marine
      - 16234 War Risk
      - 16235 Pressure Vessel Explosion
      - 16236 Riot and Civil Commotion
  - 163 Insurance on Automobiles and Trucks
  - 164 Employee's Compensation Insurance
  - 165 Premium on Surety Bonds
  - 166 Life Insurance Executives
  - 167 Employee Group Insurance
  - 168 Losses Not Covered by Insurance
- 17 Depreciation
  - 171 Depreciation and Obsolescence on Buildings and Appurtenances
  - 172 Depreciation of Furniture, Fixtures and Equipment
  - 173 Depreciation of Automobiles and Trucks
- 18 Plant Light Power and Water (Portions applicable to commercial Expense Department)
  - 181 Heat
  - 182 Light
  - 183 Power
  - 184 Water
- 19 Expense Materials and Supplies
  - 191 Packer Supplies
  - 192 Shipping Supplies
  - 193 Stationery and Office Supplies
  - 194 Gasoline and Oil
  - 195 Tires and Accessories
  - 196 Miscellaneous Supplies
- 20 Samples
- 21 Losses on Finished Goods
  - 211 Breakage
  - 212 Merchandise Sold as Scrap
  - 213 Inventory Differences
- 22 Communications
  - 221 Telephone
  - 222 Telegraph
  - 223 Teletype
- 23 Postage
- 24 Freight Express and Parcel Post (Other than Finished Goods)
- 25 Books and Periodicals
- 26 Dues
- 27 Donations

Commercial Expense Classification—Rubber Manufacturing Industry—  
(Cont'd)

- 28 Provisions for Pensions
- 29 Provisions for Bad Debts
- 30 Advertising
  - 301 Advertising space
    - Newspapers
    - Magazines
    - Posters
    - Outdoor Signs
    - Electric Signs
  - 302 Advertising Agency Service
  - 303 Art Work Service (outside)
  - 304 Radio
  - 305 Display
  - 306 Motion Pictures
  - 307 Electros
- 31 Commercial Research Bureau (outside)
- 32 Credit and Collection Agencies
- 33 Legal Service (outside)
- 34 Patent Expense (outside)
- 35 Trucking Service (outside)
- 36 Auditing (outside)
- 40 Directors' Fees and Expenses
- 41 Conventions and Conferences
  - 411 Customer Conventions
  - 412 Company Conferences
- 42 Company Publications
- 43 Miscellaneous Unclassified

The Uniform Accounting Manual for the Electrical Manufacturing Industry provides suggested classifications of what are called "General Expenses." These are defined as expenses "which relate to the distribution of the product and the administration of the business as a whole." The classification is as follows

General Expenses—Electrical Manufacturing Industry  
Subgroup 51—SALARIES

- 511 Offices and Department Heads
- 512 Selling Force
- 513 Engineers
- 514 Outside Construction Employees
- 515 Clerical Employees
- 516 Warehouse Employees
- 518 Supplementary Compensation
- 519 Other Employees
  - 5191 Advertising Employees
  - 5192 Legal Employees
  - 5199 Other Employees

Subgroup 52—COMMISSIONS

- 521 Commissions—Selling Force
- 522 Commissions—Agents

**General Expenses—Electrical Manufacturing Industry—(Cont'd)****Subgroup 53—OFFICE EXPENSE**

- 531 Rent Light Heat and Power
- 532 Office Equipment Alterations and Repairs
- 533 Telephone and Telegraph
- 534 Postage
- 535 Office Supplies

**Subgroup 54—TRAVELING AND ENTERTAINMENT****Subgroup 55—PUBLICITY EXPENSES**

- 551 Space Advertising
- 552 Other Publicity

**Subgroup 56—FIXED CHARGES**

- 561 Corporate Taxes (except Federal Income Tax)
- 562 Other Taxes
- 563 Insurance
- 564 Depreciation
- 565 Pensions

**Subgroup 57—WAREHOUSE EXPENSES**

- 571 Warehouse Carriage
- 572 Warehouse Packing and Shipping Supplies

**Subgroup 59—OTHER GENERAL EXPENSES**

- 591 Retainers
- 592 Legal Fees (except Retainers)
- 593 Unabsorbed Transportation
- 594 Concessions to Customers
- 595 Commercial Policy Changes
- 596 Accruals for Possible Losses
- 598 Expense Liquidated
- 599 Miscellaneous General Expenses

Both illustrative classifications above include administrative and distribution expenses, but this does not mean that these are combined for accounting and report purposes. Because many primary accounts found in the administrative division also exist in the distribution division a single list of primary accounts has been developed to cover both divisions. By use of code numbers, the major expense division can be indicated. Thus under the method of coding used in the rubber industry, account 85 101 is used to record the salaries of the sales function and account 86 101 the salaries of the administrative function.

**FUNCTIONAL CLASSIFICATION OF DISTRIBUTION COSTS**—Somewhat comparable to departmental classifications used in connection with production costs is the functional basis for classifying distribution costs. In a study of distribution costs conducted by the Association of National Advertisers Inc. in 1933 with the cooperation of the National Association of Cost Accountants, costs were collected for eight functional groups, of which seven were specific and one a miscellaneous group called "All Other Distribution Costs." Heckert (Analysis and Control of Distribution Costs) has followed the same classifications and has offered an explanation of what each function covers. Heckert's functional grouping is as follows:



- 1 Direct selling expense all direct expense of salesmen sales offices sales supervision and service connected therewith
- 2 Advertising and sales promotion expense all advertising sales promotion publicity educational and market development activity and expense incident thereto
- 3 Transportation expense all transportation charges on outbound goods returned sales and local deliveries maintenance and operation of outward transportation facilities and the distribution share of traffic service expense
- 4 Warehousing and handling expense the total expense of warehousing storing and handling finished goods beyond the point of production
- 5 Credit and collection expense all expenses of maintaining a credit and collection department expense of accounts receivable records collection expense and loss from bad debts
- 6 Financial expense the cost of carrying accounts receivables and finished inventories cost of fixed and working capital for distribution activities and cash discounts allowed on sales
- 7 General distribution expense the expense of distribution accounting and market research the distribution share of general administrative expense and all other expenses related to distribution activities not included above

In contrast the Uniform Accounting Manual for the Rubber Manufacturing Industry recognizes only two main selling functions namely sales promotion and selling. Following subdivisions are suggested:

#### 851 ADVERTISING

- 8511 Specific Product Advertising
- 8512 Special Customer Advertising
- 8513 Institutional Advertising
- 8514 Advertising Administration and Operating Department
- 8515 Sales Promotion Department
- 8517 Art Department

#### SELLING DEPARTMENTS

Account groups for the Selling Departments should be provided under the functional group according to each company's organization. The following list is suggested and covers the departmentalization necessary to cover the ordinary company having branch organizations.

#### 852 SALES DEPARTMENTS

- 8521 Vice President or General Manager's Department
- 8522 District Sales Manager's Department
- 8523 Branch Sales Manager's Department
- 8524 Sales Solicitation Department
- 8525 Sales Operating Department—Home Office District or Branch\*
  - Branch Auditing and Operating Administrative Department
  - Branch Operating Manager's Department
  - Merchandise Distribution Department (allocation of stock to warehouses)
  - Sales Employment and Personnel Department
  - Salesmen's Training Department
  - Sales Research Department
  - Sales Engineering
  - Price Adjustment Department
  - Order Entry Department

\* These subdepartments will appear in either the home office the district or the branch fields according to the operating organization of the company.

Credit Department  
 Billing Department  
 Accounts Receivable Department  
 Warehousing Department—Finished Goods  
 Shipping Department  
 8526 Provision for Bad Debts

Where both primary and functional classifications have been developed it is possible to classify each item of cost as incurred with respect to each classification, provided it is a direct cost of one of the functions. If it is a joint cost, i.e., benefits more than one function and it is not possible to apply it directly, **proration** becomes necessary.

**Combined Classifications**—Primary classifications may also be in the form of subdivisions of functional divisions. This type of classification is illustrated by the chart of accounts contained in the "Manual of Selling and Distributions Costs," developed by the Institute of Carpet Manufacturers of America, Inc. from which the following is taken:

**Chart of Accounts**  
**Selling and Distribution**

(Segregated by New York Office and Districts, and by  
 Wholesalers and Retailers if desired)

**SELLING EXPENSE**

Branch Sales Managers' Salaries  
 Office Salaries  
 Salesmen's Salaries and Commissions  
 Jobbers' Compensation  
 Traveling Expense (Segregation of car expense railroad, etc. if necessary)  
 Entertainment Expense (Executives and Salesmen)  
 Office Expenses  
   Rent and Light  
   Office Supplies and Expense (including telephone, telegraph, postage)  
 Training Salesmen

**ADVERTISING AND SALES PROMOTION**

Advertising  
   Consumers Magazines  
   Radio  
   Trade Publications  
 Color Plates and Catalogs  
 Display Material and Dealer Helps  
 Signs  
 Samples and Sample Losses  
 Advertising Department Salaries  
 Advertising Department Expenses  
 Agency Commissions  
 Agency Expenses  
 Display and Educational Salaries  
 Display and Educational Expenses (Traveling, etc.)

**DISTRIBUTION EXPENSES**

Mill Warehouse Expense  
 Salaries and Wages  
 Building Occupancy Expense  
 Real Estate Taxes

**Chart of Accounts—(Cont'd)**

Insurance (Including compensation)  
 Repairs and Maintenance  
 Building Depreciation  
 Sundry Expenses  
 Shipping and Packing Expense  
 Damage and Depreciation of Stock  
 Transportation  
   Trucking  
   Freight and Express to Branch Warehouses  
   Freight and Express to Customers  
   Freight and Express between Branch Warehouses  
 Branch Warehouse Expenses (Segregated by districts)  
   Salaries and Wages  
   Rent and Light  
   Shipping and Packing Expense  
   Miscellaneous Expense

**ADMINISTRATION EXPENSES (Chargeable to selling and distribution)**

Executive Salaries  
 Office Salaries (Order Department Warehouse Inventories, Sales Correspondence etc.)  
 Adjustment and Concessions  
 Traveling Expenses  
 Office Supplies and Expenses  
 Building Occupancy Expenses  
 Office Furniture Depreciation  
 Dues and Contributions Relating to Sales

**CLASSIFICATION BY MANNER OF APPLICATION—**

Analysis and classification of costs by manner of application i.e. by territories product lines method of distribution classes of customers etc. is not a continuous process and is made after the data have been accumulated rather than in connection with their accumulation. Hence there is the necessity for properly labeling original data as in aid to later analysis and classification.

In general there are two methods used in making analyses by manner of application

- 1 Unit Functional Analysis
- 2 Primary Account Analysis

**Unit Functional Analysis**—The steps in unit functional analysis are described by Rossiter (N.A.C.A. Bulletin vol 22) as follows

- 1 Determine how the costs are to be accumulated by territories method of sale products, customers all four or any combination of the four
- 2 Analyze all distribution costs by functions collect separately the costs of the functions of marketing
- 3 Determine the functional factors of variability the units of activity with which the amounts of the several functions costs vary
- 4 Develop a unit cost for each of the functional factors of variability
- 5 Determine the number of functional units required to serve the particular factor of distribution (territory product method of sale or customer) to be costed
- 6 Determine the cost of distribution for each factor by applying the information gained through the preceding steps

## DISTRIBUTION EXPENSE BUDGET AND APPORTIONMENT

MONTH OF \_\_\_\_\_

FUNCTION	FACTOR OF VARIABILITY	TOTAL EXPENSE	No of UNITS	UNIT COST	TRAMPOON No 1		TRAMPOON No 2		WAREHOUSE	
					No of Units	Total	No of Units	Total	No of Units	Total
1 Warehousing	Cwt.	\$ 958 40	47 920	\$ .02	20 400	\$ 408 00	13 500	\$ 270 00	14 020	\$ 950 40
2 Selling										
3 Salaries	Calls	2 125 00	1 700	1 25	1 000	1 250 00	700	875 00		
4 Traveling	Miles	1 050 00	21 000	05	12 000	600 00	9 000	450 00		
5 Variable Administration	Calls	425 00	1 700	25	1 000	250 00	700	175 00		
6 Advertising										
7 Direct Mail	Pieces	2 000 00	20 000	10	10 000	1 000 00	7 000	700 00	3 000	300 00
8 Publication	Sales Value (Warehouse)	148 00								
9 Dealers Helps	Circulation	420 00	14 000	03	8 000	240 00	6 000	180 00		148 00
10 Receive and Route Orders	Pieces	1 300 00	2 600	50	1 400	700 00	800	400 00	400	200 00
11 Take Order	Orders	290 00	2 900	10	1 700	170 00	1 200	120 00		
12 Deliver	Orders	33 00	1 060	03						
13 Load	Cwt	1 356 00	33 900	04	20 400	816 00	13 500	540 00	1 000	53 00
14 Bill	Cwt	140 20	14 020	01					14 070	140 20
15 Collect	Remittances	178 50	2 950	03	2 400	72 00	1 900	57 00	1 650	49 50
16 Fixed Administration	Sales Value	100 40	2 510	04	1 000	40 00	800	32 00	710	28 40
	Time Spent					650 00*		350 00†		404 50‡
		1 424 50				\$6 196 00		\$4 149 00		\$1 874 00
		\$11 969 00								

\* 50% of \$1 000 00

† 25% of \$1 000 00

‡ 20 8% of \$1 424 50

FIG 4 Functional Analysis of Distribution Costs Related to Factor of Variability

Note that under this method all costs are first allocated or charged to specific functions and that a unit rate is developed for each function in terms of that function's **factor of variability** that is its **costing unit**. In the case of warehousing the factor of variability (Fig 4) is weight and this same factor is used in developing a warehousing cost per hundred weight for use in various types of analysis such as by territories, products or customer classes. On the other hand traveling expenses are applied to territories on a per mile basis and to products and customers on a per call basis. Under this procedure, classification of costs by functions is of primary importance, and the problem of distinguishing between direct and indirect costs is one of determining whether costs are direct with respect to the function or are indirect and need to be prorated over the various functions. Once total functional costs are determined, their application to territories, products, or customer classes is on a unit functional cost basis using the functional factor of variability which appears most appropriate.

The following illustration emphasizes **functional cost analysis** as a control device (Heckert Analysis and Control of Distribution Costs).

Assume for example that a certain concern has had the following monthly experience relative to certain distribution functions:

#### I PAST EXPERIENCE

Functional Operation	Functional Unit	Number of Functional Units	Total Cost	Unit Cost
1 Salesmen's calls on prospects	Salesman's call	10 000	\$40 000	\$4 00
2 Approving credit	Individual order	5 000	500	10
3 Assembling stock for orders	Item assembled	100 000	3 000	03
4 Preparing monthly statements	Customer account	5 000	500	10

Assume next that a standard unit costs are established for the above functional activities and that a sales program is developed for a subsequent month as follows:

#### II STANDARD COSTS AND BUDGET

Functional Operation	Budgeted Number of Functional Units	Standard Unit Costs	Total Budget
1 Salesmen's calls on prospects	12 000	\$4 20	\$50 400
2 Approving credit	6 250	08	503
3 Assembling stock for orders	90 000	03	2 700
4 Preparing monthly statements	5 250	097	509

Assume further that the actual results for the month in question are as follows:

#### III ACTUAL RESULTS

Functional Operation	Actual Number of Functional Units	Total Actual Cost	Actual Unit Cost
1 Salesmen's calls on prospects	12 100	\$49 610	\$4 10
2 Approving credit	5 875	558	10
3 Assembling stock for orders	95 000	2 840	032
4 Preparing monthly statements	5 035	487	097

## IV COMPARISON OF BUDGETED AND ACTUAL COSTS WITH EXPLANATION OF DIFFERENCES

Functional Operation	Total Budgeted Cost	Total Actual Cost	Difference	Explanation of Difference	
				Volume factor	Efficiency factor
1 Salesmen's calls on prospects	\$50 400	\$49 610	(\$790)	\$420 <sup>a</sup>	(\$1 210) <sup>e</sup>
2 Approving credit	583	558	(5)	(61) <sup>b</sup>	56 <sup>f</sup>
3 Assembling stock for orders	2 700	3 040	340	150 <sup>c</sup>	\$ 190 <sup>g</sup>
4 Preparing monthly statements	509	487	(22)	(22) <sup>d</sup>	None <sup>h</sup>
Total	<u>\$54 172</u>	<u>\$53 695</u>	<u>(\$477)</u>	<u>\$487</u>	<u>(\$ 604)</u>

## CALCULATIONS

- <sup>a</sup> 12 100 - 12 000 = 100 units 100 × \$4 20 = \$420  
<sup>b</sup> 6 250 - 5 575 = 675 units 675 × \$ 09 = \$61  
<sup>c</sup> 95 000 - 90 000 = 5 000 units 5 000 × \$ 03 = \$150  
<sup>d</sup> 5 250 - 5 025 = 225 units 225 × \$ 097 = \$22  
<sup>e</sup> 4 20 - \$4 10 = \$ 10 12 100 × \$ 10 = \$1 210  
<sup>f</sup> \$ 10 - \$ 09 = \$ 01 5 575 × \$ 01 = \$56  
<sup>g</sup> \$ 032 - \$ 03 = \$ 002 95 000 × \$ 002 = \$190  
<sup>h</sup> \$ 007 - \$ 007 = 0 5 025 × 0 = 0

The following analysis of results is now possible

## ANALYSIS OF RESULTS

**Salesmen's Calls**—It was planned to make 12 000 calls on customers actually 12 100 calls were made This number of calls should have cost \$50 420 (12 100 × \$4 20) actually the cost was \$49 610 hence there was an efficiency saving in this activity of \$1 210

**Approving Credit**—It was expected that 6 250 credit approvals would be necessary actually only 5 575 were made This number should have cost \$502 (5 575 × \$ 09) actually the cost was \$558, hence this department caused an efficiency loss of \$56

**Assembling Stock for Orders**—It was expected that 90 000 items of stock would be assembled actually 95 000 items were assembled This number should have cost \$2 850 (95 000 × \$ 03), actually the cost was \$3,040, hence, there was an efficiency loss of \$190

**Preparing Monthly Statements**—It was expected that 5 250 monthly statements would be prepared and mailed actually only 5 025 were sent This number should have cost \$487 (5 025 × \$ 097) which was also the actual cost hence the performance of this operation was exactly at standard with a unit cost of \$ 097

It should be noted that a comparison of the budget and actual costs in themselves does not give a true picture of the results The cost of salesmen's calls for example is \$790 less than budgeted but the actual saving effected in this activity is \$1 210 In the approval of credit there is a reduction of \$5 from the budget but actually there has been an efficiency loss of \$56

**Steps in Primary Account Analysis**—Steps in what is called "primary account analysis" are summarized by Heckert (The Analysis and Control of Distribution Costs) as follows

- 1 Determine which analyses should be made
- 2 Classify the costs as to those which are direct and indirect in relation to each analysis used

- 3 Select suitable bases of allocation to be applied to the indirect cost items
- 4 Apply the bases selected
- 5 Prepare the final analyses and their interpretation for executive use

Under this method **functional classification** may be ignored or it may be used as a basis for grouping costs. In such a case, application to territories, products, classes of customers etc., is not made by use of a single rate for each function, but by application of individual items of costs as collected in primary expense accounts.

In using this method, classification of costs as direct or indirect has reference to the territory, product, or customer classes rather than to the function. It is customary when using this method to divide expenses into three groups:

- 1 **Direct Costs** those costs which can be associated specifically with individual territories, products or classes of customers
- 2 **Semi-Direct Costs** those costs which cannot be applied directly but for which some dependable basis for measurement and allocation is available. Thus cost of trucking might be distributed on a per mile basis or publication advertising on a circulation basis
- 3 **Indirect Costs** those items of cost for which there is no logical or measurable basis for application to territories, products, customer classes etc. Institutional advertising and general executive salaries fall in this division

## Symbols and Codes

**NEED FOR SYMBOLS**—Symbols are the shorthand of classification. By use of symbols and codes relationships may be indicated in an orderly way and lengthy descriptions reduced to simple form. Today in industry it is usual to develop sets of symbols, called codes for a variety of data subject to classification. Cost accountants need to be familiar with many codes in order to classify properly.

- |                                      |                        |
|--------------------------------------|------------------------|
| 1 Material, parts and finished goods | 4 Jobs and departments |
| 2 Labor operations                   | 5 Tools                |
| 3 Expenses                           | 6 Fixed property       |

It is obvious that the great mass of data which passes through an industrial cost department can be handled more expeditiously and usually with less chance for error if systems of symbols in the form of codes have been developed for each classification of major importance.

Heckert (Accounting Systems) states the general purposes of a symbol system to be the following:

- 1 To locate accounts quickly
- 2 To give definiteness to the accounting plan
- 3 To reduce the clerical work involved in making entries on material requisitions, time tickets, production orders, expense orders, etc.
- 4 To aid in classifying transactions
- 5 To aid the memory
- 6 To facilitate mechanical sorting and tabulating

Thompson (Accounting Systems: Their Design and Installation) suggests that accounts be coded because they constitute aids in

- 1 Arranging account chart
- 2 Classifying transactions
- 3 Memorizing accounts
- 4 Locating accounts in ledger
- 5 Mechanical tabulation and sorting

In addition Hecksit suggests that to serve its purpose, a symbol system should possess following characteristics:

- 1 It should be a simple efficient system
- 2 It should be easy to remember
- 3 It should be sufficiently flexible to accommodate itself to normal growth and change in the business
- 4 It should lend itself to definite interpretation

**TYPES OF CODES**—The method of symbolizing may be through

- 1 Numbering system
- 2 Decimal system
- 3 Mnemonic system

Variations of these systems are of course possible, particularly through a combination of letters and numbers.

**NUMERICAL CODES**—The simplest type of code is that obtained by assigning to items to be coded numbers from 1 up. Actually there are three kinds of numerical codes:

- 1 Sequence codes
- 2 Block codes
- 3 Group classification

**Sequence Codes**—These are useful only when there is no need for subdivision by groups. Items to be coded should be arranged in some logical order before numbers are assigned. Since numbers are assigned in sequence, additions can be made only at the end of the classification by adding additional numbers. In accounting, sequence codes are commonly used in connection with job requisitions and other papers which are numbered in sequential order according to date of issuance.

To provide for grouping of data, **block codes** are often used. Thus numbers from 0 to 9 might be set aside for asset accounts, 10 to 19 for liability accounts, etc. Limited expansion is provided under this method by reserving certain numbers for future use. Note that under the block code method the number used signifies the group to which item belongs as well as the specific item. Thus, number 11 might signify that the account was a liability account and also that it was a specific account, Notes Payable. Normally, there is no provision for subdivision in a block code.

**Example of Block Code**—The chart of accounts contained in the "Cost Manual and Accounting Control for Woven Underwear" issued by the Underwear Institute illustrates how a block code can be applied to a complete set of cost accounts. A study of the account numbers in this chart indicates the provision which has been made for expansion, and the way in which each number indicates the major class as well as the individual account. The complete chart applies also to the financial accounts.



## Chart of Manufacturing Costs and Commercial Expenses

Account	No
<b>RAW MATERIAL ACCOUNTS</b>	
Fabrics Cloth Piece Goods	350
(Separate accounts may be kept for different kinds of cloth)	
Tapes	351
Elastics	352
Buttons	353
Thread	354
Pin Tickets and Labels	355
Sundry Other Materials	356
Boxes	357
Box Department Materials	358
(More detailed accounts may be provided and separate accounts may be provided for each mill)	
<b>DIRECT OR PRODUCTIVE LABOR ACCOUNTS</b>	
Laying Up and Cutting	371
Finishing—Sewing, Buttonholing, etc	372
Inspection or Examining	373
Pressing	374
Boxing	375
(Separate accounts may be kept showing more accurate classifications and accounts recording piece and day labor separately may be provided also, separate accounts for each mill may be provided)	
<b>INDIRECT OR NONPRODUCTIVE LABOR ACCOUNTS</b>	
Superintendence or Supervision	390
Laying Up and Cutting	391
Finishing—Sewing, Buttonholing, etc	392
Inspection or Examining	393
Pressing	394
Boxing	395
Mill Office	396
General Nonproductive Salaries and Wages	397
(Separate accounts may be kept showing more detailed classifications for each mill)	
<b>OTHER FACTORY OVERHEAD ACCOUNTS</b>	
Sewing Machine Needles	411
General Mill Supplies	412
Mill Office Supplies	413
Box Department Supplies	414
Fuel	415
Power and Light	416
Water	417
Taxes (Real Estate County City School Personal Property, etc)	418
Repairs and Maintenance	419
Insurance—Fire, Liability, etc	420
Rents	421
Machinery Rentals or Royalties	422
General Mill Expenses	423
Fueling or Automobile Expenses	424
Freight and Cartage In (When not included with cost of raw materials or supplies)	425

## Chart of Manufacturing Costs and Commercial Expenses—(Cont'd)

Account	No
Depreciation on Mill Buildings and Machinery and Equipment	426
Waste or Spoilage	427
(Separate accounts may be provided to show more detailed classifications for each mill or for each department of the mill)	

## SELLING EXPENSE ACCOUNTS

Salesmen's Salaries	511
Salesmen's Commissions	512
Salesmen's Traveling Expenses	513
Sales Office Salaries	514
Branch Office Salaries	515
Entertaining Expenses	516
Branch Office Expenses	517
Samples	518
Advertising	519
Telephone and Telegraph	520
Printing and Stationery	521
Postage	522
Rent, Light and Heat	523
Depreciation on Sales Department Equipment and Automobiles	524
Shipping Department Wages	525
Shipping Department Supplies	526
Stockroom Wages	527
Stockroom Supplies	528
Dues and Subscriptions	529
Repairs—Office Equipment	530
Insurance	531
Taxes	532
Collection Expenses	533
Bad Debts	534
Sundry Other Selling Expenses	535
(More detailed selling expense accounts may be provided and separate detailed accounts may be kept for each sales branch or sales territory)	

## ADMINISTRATIVE EXPENSE ACCOUNTS

Executive Salaries	611
Office Salaries	612
Traveling Expenses	613
Legal and Professional Services	614
Telephone and Telegraph	615
Printing and Stationery	616
Postage	617
Rent, Light Heat	618
Dues and Subscriptions	619
Donations	620
Insurance	621
Interest Paid	622
Depreciation on Office Equipment, etc.	623
Repairs—Office Equipment	624
Taxes	625
Experimental and Development Expenses	626
Miscellaneous Administrative Expenses	627
(More detailed administrative expense accounts may be kept and separate accounts may be provided for each administrative branch)	

**Group Classification**—Probably the method of coding most commonly used in accounting is that providing for group classifications by having major and minor classifications represented by succeeding digits of a number. This plan allows for indefinite subdivision. The first digit in a code number represents the **major classification**, the second digit the **secondary classification**, and subsequent numbers finer subdivisions. Normally it is best to decide in advance the degree of subdivision desired and express all code numbers by the same number of digits. Thus a code such as

1000—Assets  
1100—Current assets  
1110—Cash  
1111—Petty Cash

requires four digits. If other parts of the code require further subdivision, it is desirable to add another digit to above numbers in order that all code numbers may have the same number of digits and the **position of each digit** from either left or right may have same significance. The system of coding used in the Uniform Cost Manual for the Electrical Manufacturing Industry (page 143) shows how group classification can be used in connection with classification of expense accounts.

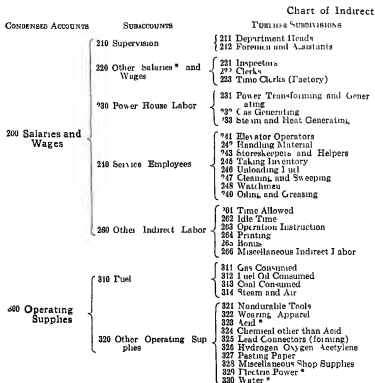
**DECIMAL CODES**—This type is particularly useful where it is desired to combine two fairly extensive classifications, as for example departments and expense accounts or a functional and a primary classification of expenses. Coding at the left of decimal point is the same as for a regular group classification. Figures to the right of the decimal provide for further subdivisions or for classification on another base.

An interesting application of decimal classification is found in the Uniform Accounting Manual for the Rubber Manufacturing Industry. Major account classifications are assigned numbers from 1 to 9 as follows:

- 1 Cash Marketable Securities and Receivables
- 2 Merchandise Materials and Goods in Process
- 3 Properties Plants and Securities
- 4 Prepaid Deferred and Miscellaneous Assets
- 5 Goodwill Patents and Trade Marks
- 6 Current Liabilities
- 7 Fixed Liabilities Capital Stock and Surplus
- 8 Income and Expense on Sales
- 9 Other Income and Expense

Each of these major classifications is further subdivided. Thus "Income and Expense on Sales" is subdivided as follows:

- 81 Sales
  - 81 1 Sales (Own Products)
  - 81 2 Sales (Outside Products)
  - 81 3 Returned Goods
- 82 Deductions from Sales
- 83 Cost of Sales
  - 83 1 Cost of Sales (Own Products)
  - 83 2 Cost of Sales (Outside Products)
  - 83 3 Cost Variances
- 84 Unused Code Numbers
- 85 Selling Expense
- 90 Administrative Expense



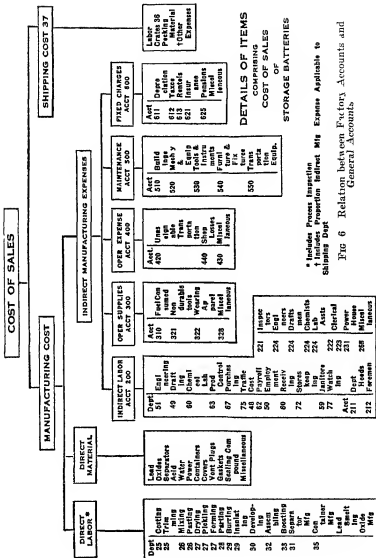
\* Other than included in direct costs

FIG 5 Chart of

## Manufacturing Expense

CONDENSED ACCOUNTS	SUBACCOUNTS	FURTHER SUBDIVISIONS
400 Operating Expenses	420 Unassignable Transportation and Demurrage	421 Unassignable Transportation 422 Demurrage
	430 Other Operating Expenses	431 Traveling Expenses 432 Postage 433 Stationery 434 Telephone and Telegraph 435 Rearranging Equipment 436 Miscellaneous Expenses
	440 Shop Losses	441 Defective Workmanship 442 Defective Purchased Materials 443 Other Losses due to Defects or Errors 444 Reworking Finished Product
500 Maintenance	510 Buildings	511 Buildings and Structures 512 Fences Gates and Grounds 513 Piping and Wiring—Outside 514 Piping and Wiring—Inside
	520 Machinery and Equipment	521 Forming Tanks 522 Drying Equipment 523 Conveyors 524 Elevators 525 Punch Presses 526 Mixers and Pasting (Machine) 527 Motors 528 Melting Furnaces 529 Other Machinery and Tools
	530 Tools and Instruments	531 Molds 532 Dies 533 Burning Forms 535 Electrical Apparatus
	540 Furniture and Fixtures	541 Factory Fixtures 542 Furniture and Appliances
	550 Transportation System	551 Roads Driveways and Sidewalks 552 Railway Tracks 553 Rolling Stock 554 Automobiles 555 Gasoline Trucks and Tractors 556 Industrial Trucks
600 Fixed Charges	610 Depreciation Taxes and Rentals	611 Depreciation 612 Taxes 613 Rentals
	620 Other Fixed Charges	621 Insurance 622 Accident Compensation 623 Group Insurance 624 Shop Vacation Allowance 625 Pensions

## Accounts



In general, the code presented in this manual utilizes only two digits before the decimal point, finer classification being indicated by decimals. But in the case of expense classifications where both primary and functional classifications are desired digits after the decimal are reserved to indicate primary classification but a three-, four-, or five-digit figure may be used to indicate major classification, subclassification, function, subfunction, and division of the subfunction. Thus figure 86 is assigned to Administration, 867 to the Comptroller's Division, 8675 to the general accounting division of Comptroller's Division, and 86752 to accounts payable department in the general accounting division. Code numbers following the decimal point are then used to indicate primary expense accounts. Thus code 86752 101 would serve to designate salaries in accounts payable department, and code 86752 193 stationery and office supplies for that department.

**FLEXIBLE CODES**—Many industries contain both large and small companies, and trade association groups sponsoring uniform accounting methods have had to consider the needs of plants of various sizes. In some cases, separate accounting manuals have been developed for smaller plants in addition to more extensive manuals for large and medium-sized plants. In other cases, needs of plants of various sizes have been recognized by developing a chart of accounts which might be expanded or contracted to meet the needs of the specific company. The way in which this is done and a code developed is illustrated by the chart of indirect manufacturing expense (Figs 5 and 6) from the "Report on Uniform Accounting Procedure" issued by the National Battery Manufacturers' Association.

**LETTER CODES**—In addition to numerical codes, letters may be used to provide code designations. Letters may be used alone or in combination with figures. They may be assigned in alphabetical order or according to the sound of the name of the individual item being classified. Symbols of this latter type are called **mnemonic symbols**, because they are designed to assist the memory. Thus in a classification of accounts, the letter "A" might be assigned to Assets, "L" to Liabilities, "X" to Expenses, etc. A second letter may be used to indicate subsidiary classification; for example, "AC" might indicate Current Assets and "AF" Fixed Assets. Mnemonic symbols are used more commonly by engineers than accountants, and are quite often found in use in classifying materials. Fig. 7 from a chapter on "Classification and Symbolization" by Cooke (Scientific Management in American Industry) illustrates the way in which mnemonic symbols may be applied in classifying materials.

Use of letter symbols in conjunction with figures to provide a code of accounts is illustrated by Bennett (N. A. C. A. Bulletin, vol. 19). In this chart of accounts (Fig. 8) for a furniture manufacturer, the letters from "A" to "M" are used to represent main classifications, while numbers are added to indicate specific accounts. Thus account B 12 is Work in Process Burden. Note that the letter in all cases has special significance but there is no relationship between accounts with the same number, since in the latter case they represent accounts appearing on the same line in the chart but falling into different classifications.

S—CLASSIFIED STORES		SV—MISCELLANEOUS CLASSIFIED STORES	
SA		SV A	Miscellaneous stores—not other
SB			wise classified
SC		SV B	Brass and copper products made
SD			chiefly from same
SE		SV C	Cast iron and products made
SF			chiefly from same
SG	Special classified stores for grinders	SV D	
SH		SV E	
SJ		SV F	
SK		SV G	
SL	Special classified stores for Taylor	SV H	
	system apparatus	SV I	
SM	Special classified stores for molding	SV J	
	machines	SV K	
SN	Special classified stores—miscellaneous	SV L	Liquids and products made chiefly
	on		from same
SP	Special classified stores for pattern	SV M	Miscellaneous metals other than
	fitting and repair work		non steel brigs and copper
SR	Special classified stores for milling	SV N	Composite materials
	cutters	SV P	Textile and fibrous materials
SS		SV R	
SI	Special classified stores for Taylor	SV S	Steel wrought iron and products
	Newbold saws		made chiefly from same
SU		SV T	Tools and implements
SV	Miscellaneous classified stores or	SV U	
	stores for a variety of purposes	SV V	
SW		SV W	Wood and products made chiefly
SX			from same
SY		SV X	Mineral products
SZ		SV Y	
		SV Z	Lasting bolts nuts etc

Fig. 7 Mnemonic Stores Classification

A similar plan of classification is illustrated with accounts selected from the Monton Salt Co. In this company, departmental classifications are first established as follows:

1 Boiler Room	8 Cooper Shop
2 Vacuum Pans	9 General
3 Grainers	10 Packing and Loading
4 Pump House and Engine	11 Machine and Carpenter Shop
Room	12 Works Office and Laboratory
5 Tanks and Settlers	13 Block Salt Department
6 Wells	14 Smoke Salt
7 Darry Mill	

Expense classifications are then selected and letters applied to each expense account:

A Operating Labor	G Warehousing
B Supplies	H Trains and Doels
C Repair Labor	I Sewals
D Repair Material	J Yard
E Fuel	K Electric Wiring
F Unloading and Handling	L Fire Protection
fuel	

The expense accounts are used in conjunction with departmental accounts by use of number and letter classifications. Account 2-A is operating labor for vacuum pans, 6-D repair material for wells, 1-F unloading and handling for boiler room. This company operates several plants and carries out the same plan of account classification at each plant. A prefix is used to designate the plant.



ASSETS				LIABILITIES				REVENUE AND EXPENSE				
A	B	C	D	E	F	G	H	I	J	K	L	M
CURRENT	INVENTORY	FIXED	DEFERRED	CASH	RECEIVABLES	DEBIT	CREDIT	SALES	DEDUCTIONS	EXPENSES	OTHER	OTHER
1	2	3	4	5	6	7	8	9	10	11	12	13
1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9	9	9	9
10	10	10	10	10	10	10	10	10	10	10	10	10
11	11	11	11	11	11	11	11	11	11	11	11	11
12	12	12	12	12	12	12	12	12	12	12	12	12
13	13	13	13	13	13	13	13	13	13	13	13	13
14	14	14	14	14	14	14	14	14	14	14	14	14
15	15	15	15	15	15	15	15	15	15	15	15	15

FIG 8 Chart of Accounts Combining Numerical and Letter Coding

**CHARTS OF ACCOUNTS**—Where a complete system is maintained it is essential that an index or record of accounts be kept for use of persons employed. The term "chart of accounts" has been applied to listing of accounts used with account numbers or symbols, separately or combined and with or without explanatory instructions.

**How Prepared**—Preparation of a chart of accounts requires a thorough knowledge of the business. A chart of accounts includes accounts related to the balance sheet and also accounts related to the profit and loss statement. Hence, a good starting point in its preparation is to construct pro-forma copies of the balance sheet and profit and loss statement in the form desired by management. These statements may then serve as the starting point for the account classification in the chart of accounts. In setting up the chart, accounts are arranged in the order in which they occur on the statements.

Most balance sheets and profit and loss statements represent condensations of numerous accounts kept in the various ledgers but expressed in summary form on the statements. Thus there may be many cash accounts including many petty cash funds, which however, appear on the balance sheet simply as "Cash on Hand and in Banks." In addition the formal closing of the books requires the use of **summary or group accounts**, which in turn are closed out into other accounts. It is necessary therefore to have an intimate knowledge of the method of closing and the accounts required in the closing process so that those accounts which do not appear in the statements are nevertheless provided for in the chart of accounts.

### Cost Classifications for Government Contracts

**TOTAL COST UNDER GOVERNMENT CONTRACTS**—At present, the United States government generally follows the principle of obtaining needed supplies and equipment through the use of negotiated contracts or on the basis of some modification of **cost plus**. This at once raises question of what costs are allowable in connection with cost determination under such contracts. The matter is covered in Section 269 of Treasury Decision 5000. There cost is defined as follows:

The cost of performing a particular contract or subcontract shall be the sum of

- 1 The direct costs including therein expenditures for materials direct labor and direct expenses incurred by the contracting party in performing the contract or subcontract
- 2 The proper proportion of any indirect costs (including therein a reasonable proportion of management expenses) incident to and necessary for the performance of the contract or subcontract

Such cost is made up of the following elements

- 1 Manufacturing cost
- 2 Miscellaneous direct expenses
- 3 General expenses which are the sum of indirect engineering expenses usually termed "engineering overhead" and expenses of distribution servicing and administration
- 4 Guarantee expenses

Items of cost that enter into government contracts are classified by Healy (NACA Bulletin, vol 24) in logical outline as follows

## Elements of Cost under Treasury Decision 5000

## A MANUFACTURING COST

## Factory Cost

- Direct materials
- Direct productive labor
- Direct engineering labor
- Miscellaneous direct factory charges
- Indirect factory expenses
  - Labor
  - Material and supplies
  - Service expenses
  - Fixed charges and obsolescence
  - Miscellaneous indirect factory expenses

## Other Manufacturing Cost

- Royalty payments
- Amortization of cost of designs and patents
- Amortization of experimental and development costs
- Other items of manufacturing costs not properly chargeable as factory costs

## B MISCELLANEOUS DIRECT EXPENSES

## Cost of Installation and Construction

## Materials

## Labor

## Expenses

## Sundry Direct Expenses

- Premiums on performance or other bonds
- State sales taxes imposed on contracting party
- Freight on outgoing shipments
- Fees for wind tunnel and model basin tests
- Demonstration and test expenses
- Crash insurance premiums
- Traveling expenses (subject to limitations)
- Other properly chargeable items not constituting guarantee expenses or manufacturing costs

## C GENERAL EXPENSES

## Indirect Engineering Expenses

## Labor

## Material

## Miscellaneous expenses

## Expenses of Distribution Servicing and Administration

## Compensation for personal services of employees

## Bidding and general selling expenses

## General servicing expenses

## Other expenses

## D GUARANTEE EXPENSES

- Costs incurred after delivery or installation of the article manufactured or constructed which are incident to correction of defects or deficiencies

The government does not insist on the above classification in contractor's accounts so long as the system furnishes information called for (See list of unallowable items on following pages)

**DIRECT MATERIAL AND LABOR**—Materials used and labor actually employed in connection with government contracts are properly

charged as costs of such contracts. Material costs include handling charges. Labor costs include compensation insurance and social security taxes.

**DIRECT ENGINEERING LABOR AND SHOP ENGINEER-  
ING EXPENSE**—Engineering labor covers compensation of professional engineers and other technicians (including reasonable advisory fees), and of draftsmen properly chargeable directly to the cost of the contract or subcontract. Engineering labor is a part of shop engineering expense, which in addition includes expenses in the nature of overhead of the engineering departments for supervision, clerical aid, stationery and drafting supplies, fixed charges and maintenance of engineering equipment, etc. The work covers preparation of designs, blueprints and specifications, also study and improvement of shop methods and procedures. Such work must be immediately related to current production as distinguished from research and development costs which are usually put off the plant overhead or are deferred.

**MISCELLANEOUS DIRECT FACTORY CHARGES**—A special government bulletin entitled "Explanation of Principles for Determination of Costs under Government Contracts" lists under this heading:

- 1 Manufacturing royalties or license fees
- 2 Amortization of initial cost of dies, patterns and special tools on the basis of useful life.

These are identifiable with specific operations or products.

Under this heading, too, comes amortization of the costs of rearrangement of plant facilities where such costs are incurred in connection with production under government contracts. However, ordinary rearrangement of facilities not directly attributable to production under government contracts should be treated as manufacturing overhead.

Other direct charges are listed in a later section of TD 5000 as follows:

- 1 Cost of installation and construction
- 2 Sundry direct charges as listed in the outline shown earlier.

**Installation and construction costs** include materials, labor and expense necessarily incurred in the erection of contract facilities. According to the special government bulletin referred to above,

when the terms of the contract require that the contractor install, erect, test or otherwise construct or assemble the product or material manufactured, the cost of materials, labor and expense for such installation and of general servicing for ordinary adjustments or minor defects after the delivery of the product but necessary for the completion of the contract is a proper charge to the cost of fulfilling the contract.

As to delivery expenses the same source states:

When outward freight and transportation are incurred under a contract for delivery of the products manufactured, the actual amounts of such charges paid or incurred are proper costs thereof.

When delivery is effected through the contractor's own shipping facilities, a proper and equitable proportion thereof, including a reasonable share of plant shipping department facilities, the expense of which is not included in indirect shop costs, may be treated as a cost under the contract.

The contractor should keep detailed records of any item of cost of the character here indicated sufficient to disclose clearly that the costs relate specifically to the contract and that no part thereof is properly chargeable to other work nor included in any part of indirect costs elsewhere

### FACTORY OVERHEAD IN GOVERNMENT CONTRACTS

—This consists of indirect factory expenses not directly identified with the contract costs but which are properly incident to and necessary for the performance of the contract. They include items discussed below

**Indirect Labor**—This covers all salaries and wages chargeable to factory operations except those classed as direct labor. It covers, in productive departments, supervision, such as wages of foremen, assistant foremen, timekeepers, inspectors, shop clerks, also machine maintenance men such as machine adjusters, tool setters, tool crib attendants, cleaners, oilers, also crane operators, general laborers, etc. Included also are all salaries and wages of service or auxiliary departments such as stores rooms, receiving, shipping, factory offices, laboratories, employment and personnel, etc

**Materials and Supplies**—The special government bulletin above referred to explains this as follows

Under this description fall all supplies needed for general use in the factory in current operations such as fuel lubricants heat treating fluxing cleaning and anodizing supplies nondurable or small tools gauges, factory office supplies boxing and wrapping materials etc. The term supplies relates to a wide variety of miscellaneous materials the peculiar characteristic of which is that they are needed for the operation of the shop rather than to become a part of the product (although as stated, some materials which are actually applied to the product may be treated as supplies). The terms "nondurable tools" and "small tools" refer to small portable tools which have a comparatively short term of effective life such as axes, bits, chisels, drills, threading dies, templates, etc

**Service Expenses**—These include all normal factory expenses other than those specifically set forth above or in succeeding paragraphs. Under this heading T.D. 5000 contemplates particularly normal expenses of service and maintenance departments, such as those for power, heat, light (purchased or produced), water, gas, compressed air, ventilation, air conditioning and for the operation and maintenance of plant assets and facilities. Ordinarily, separate accounts are created for these service departments, and made to include all charges for labor material and supplies and fixed charges

Extraordinary service items should be charged to special accounts, since their admissibility as proper contract charges may be questioned

**Fixed Charges**—The special government bulletin includes under this heading the following recurring charges with respect to properties used for manufacturing purposes

- 1 Premiums for various kinds of property insurance
- 2 Property and plant taxes
- 3 Rentals
- 4 Allowances for depreciation and obsolescence of property and equipment (including reasonable stand by equipment) but excluding under this heading amortization of special war production facilities

In making allowances for depreciation the rates used should be based on cost and should be such as to provide for normal exhaustion, wear and tear and for obsolescence. Consideration may be given to an extended number of machine hours due to multi shift operation. Amortization of unutilized appreciation of values of assets and depreciation of excess facilities are not admissible.

- 5 Depletion of natural resources. Depletion is generally calculated on a unit basis intended to amortize the estimated content of a mineral deposit or other natural resource over the period of its expected life. Depletion for purposes of arriving at costs should generally be calculated on the basis of the actual cost of the property rather than on a basis arrived at for income tax purposes.

**Miscellaneous Indirect Factory Expenses**—Other indirect shop costs include miscellaneous factory expenses not directly attributable to the contract but necessary and incidental to services operations, plant equipment or facilities involved in the performance of the contract, such as

- 1 Ordinary and normal rearrangement of facilities within a department or plant
- 2 Employees welfare expenses
- 3 Vacation pay
- 4 Premiums or dues on compensation insurance, not elsewhere included
- 5 Employer's payments to unemployment, old age and social security funds, not elsewhere included, not including amounts deducted from employees' pay
- 6 Pensions and retirement payments to factory employees
- 7 Factory accident compensation
- 8 Amortization of the initial cost of dies, patterns, drawings and special equipment when not logically or practically a direct shop cost

**OTHER MANUFACTURING COSTS**—Certain costs related to the manufacture of products under a contract are sometimes not satisfactorily included under shop costs and are preferably to be set down as separate items of manufacturing cost. Examples of such items are

- 1 Amortization of patents, etc.
- 2 Engineering and development expenses

**INDIRECT ENGINEERING EXPENSES**—These are part of the general plant expenses. Indirect engineering expenses or engineering overhead include the general engineering expenses shown below.

- 1 Labor. Reasonable fees of engineers employed in a general consulting capacity and compensation of employees for personal services to the engineering department such as supervision which is properly chargeable to the contract or subcontract but which is not chargeable as direct engineering labor.
- 2 Material. Supplies for the engineering department such as paper and ink for drafting and similar supplies.
- 3 Miscellaneous Expenses. Expenses of the engineering department, such as
  - a Maintenance and repair of engineering equipment.
  - b Services purchased outside of the engineering department for blueprinting, drawing, computing and like purposes.

**DISTRIBUTION COSTS IN GOVERNMENT CONTRACTS**—Expenses of distribution, servicing and administration are a part of

general expenses in determining the cost of performing a contract and are incurred in connection with the distribution and general servicing of the contracting party's products and the general administration of the business. These expenses include

- 1 Compensation for personal services of employees
- 2 Bidding and general selling expenses
- 3 General servicing expenses
- 4 Other expenses

**Compensation for Personal Services of Employees**—These services cover salaries and other compensation of the general office

- 1 Compensation for personal services
  - a Salaries of corporate officials, executives and department heads
  - b Salaries and wages of administrative clerical employees and of office service employees
  - c All incidental employer's payments for unemployment, old age, and social security federal and state funds

**Bidding and General Selling Expenses**—Under this heading are included, according to the special government bulletin,

ordinary expenses in connection with preparing and submitting bids or with negotiations upon estimated costs but do not include any experimental or development work preceding bids or negotiations. General selling and distribution expenses include any other costs of selling and distribution insofar as these can be justified as properly incidental to and necessary for the performance of the contract. Their treatment as general expenses, however, is in lieu of any direct charges that might otherwise be made.

**General Servicing Expenses**—Expenses which by reference to all the pertinent facts and circumstances reasonably constitute a part of the cost of performing a contract and which are incident to delivery or installation of articles requiring ordinary adjustments of minor defects. These expenses are exclusive of guarantee expenses and expenses charged directly. Guarantee expenses include those costs incurred after delivery of the product or installation of a construction project. Such costs are necessary to correct defects as provided in the guarantee clauses of the contract.

**Other Expenses**—These cover broadly administration and general corporate expenses

- 1 All ordinary and miscellaneous office and administrative expenses, such as stationery and office supplies, postage, repairs and depreciation of office equipment, rentals paid and the cost of all necessary office services
- 2 Employees' welfare expenses including the cost of pension and retirement provisions for administrative and office employees
- 3 Premiums or dues on compensation insurance not elsewhere included
- 4 Professional fees and expenses for legal, accounting, and other consulting services
- 5 Contributions to local charitable or community and similar organizations to the extent constituting ordinary and necessary business expense
- 6 Dues and memberships in regular trade associations
- 7 State and local taxes (other than income taxes) not elsewhere included

**SELF-INSURANCE**—Under miscellaneous government contract costs may be listed those costs incurred by a contractor who carries his own insurance risks, ordinary insurance payments are allowable costs to the extent of actual losses suffered or payments incurred during, and in connection with contract performance. Self-insurance is also a permissible cost provided

- 1 Rates used do not exceed the lawful rates of insurance companies
- 2 Contractor adopts or follows this method consistently on all subsequent government contracts

**INADMISSIBLE COSTS UNDER GOVERNMENT CONTRACTS**—What constitutes cost is purely a matter of definition. Thus certain items are not admissible for the purpose of computing the cost of performing a government contract. The contractor's accounts should provide for suitable analysis to distinguish between possibly admissible and inadmissible costs. The latter cover

- 1 Allowances for interest on invested or borrowed capital however represented
- 2 Commissions, bonuses and special premiums under whatever name, paid in connection with negotiations for or procurement of a government contract. However, bonuses paid to employees (not to officers) in pursuance of a regularly established incentive bonus system may be allowed as a cost of contract performance. (See below under Unreasonable Compensation.)
- 3 Entertainment expenses
- 4 Dues and memberships other than in regular trade associations
- 5 Donations are disallowed except those considered as constituting ordinary business expenses
- 6 Losses on other contracts
- 7 Losses from sale or exchange of capital assets
- 8 Extraordinary expenses arising from strikes or lock outs
- 9 Fines and penalties
- 10 Amortization of unrealized appreciation of values of assets
- 11 Expenses maintenance depreciation and obsolescence of excess facilities other than reasonable standby facilities. Such excess facilities include idle land and building, idle parts of a building, excess machinery and equipment vacated or abandoned or not adaptable for use in performing contracts or subcontracts.
- 12 Increases in reserve accounts for contingencies repairs compensation insurance (except as provided with respect to self insurance) and guarantee work
- 13 Income and excess profits taxes. In order that contract costs may be set forth clearly the amount of excessive profits repayable to the government are not to be included in such costs
- 14 Bond discounts or other finance charges
- 15 Life insurance premiums on the lives of officers
- 16 Special legal and accounting fees incurred in connection with reorganization, security issues, capital stock issues, patent infringement or anti-trust litigation, and the prosecution of claims of any kind (including income tax matters) against the United States
- 17 Taxes and expenses on issues and transfers of capital stock and bonds, also social security taxes deducted from employees
- 18 Losses on investments
- 19 Bad debt losses and charges to reserves therefor, also expenses of collection and exchange



20 Commercial advertising Advertising is an inadmissible item of

21

22

tract or subcontract may include only reasonable payments for these items. Excessive and unreasonable payments whether in cash, stock or other property ostensibly as compensation for services are not to be included in the cost of performing a contract. The test of admissibility in part is whether the aggregate compensation paid to each individual is for services actually rendered in connection with necessary contract performance and whether the amount is reasonable. The following items are sure to be inadmissible:

- a Total compensation paid to an individual person in excess of \$25 000 per annum or as modified by government regulations
- b Compensation which has been increased disproportionately or unreasonably since June 30 1940
- c Bonuses paid based upon a percentage of the profits
- d Royalties paid to officers or employees

**PRORATION OF COSTS UNDER GOVERNMENT CONTRACTS**—Proper cost classification for government contracts is only a first step in furnishing necessary details. In addition total costs must be analyzed to show costs for

- 1 Civilian business
- 2 Government business segregated for each of the services and lend lease aid

Finally costs other than direct charges must be allocated to specific contracts.

**PRODUCTION COST ANALYSIS FOR GOVERNMENT CONTRACTS**—The major principles involved in allocation of indirect production costs in government contracts are covered in a special government bulletin. The methods set forth below are acceptable.

**Factory Indirect Expenses**—The same principles are followed as in ordinary cost procedure.

- 1 Division of plant into departments and cost centers
  - a Producing departments and centers
  - b Service departments and centers

- 2 Account classification (standing orders) following departmental lines
- 3 Distribution of costs to departments (direct departmental charges)
- 4 Redistribution of service department costs (indirect production department charges)

The degree of refinement in departmental analysis depends upon the size and variety of the operation of the individual enterprise. In smaller plants the number of departmental accounts and the extent of the analysis of the individual items of costs are lower and simpler than are required in a larger plant.

**Departmental Burden Rates**—Total producing department charges (consisting of direct and redistributed expenses) are reduced to burden rates. Section 269(j) of TD 5000 mentions application on basis of direct labor cost. However the special government bulletin specifically advocates use of departmental rates based on the usual factors:

- 1 Per cent of direct labor dollars
- 2 Dollars per man hour
- 3 Dollars per machine hour
- 4 Dollars or cents per unit (weight quantity, length area cubic content, etc.)

In a small plant or within a department of a larger plant where labor constitutes an important part of cost and where the investment per man and the rates of pay are substantially uniform a percentage of direct labor cost is a simple and satisfactory method of expense distribution. On the other hand where labor is a relatively minor part of cost and depreciation repairs supplies and maintenance of machinery are relatively large the expenses are more equitably applied on the basis of machine hours. When direct labor appears to be a logical basis but rates of pay are not substantially uniform the expenses may be absorbed more equitably by means of rates per man hour. Again in other cases in which these methods are not logical or practicable, but a common unit of measurement exists representing volume of production for a particular process the expenses may be absorbed by means of a rate per unit.

**Shop Engineering Expense**—Usually shop engineering expenses are accumulated by jobs or projects and thus related to particular products. Amounts of the respective expenses can be reduced to percentages of direct labor cost or of the direct shop cost of production. By this means a ratable share of the shop engineering expenses can be apportioned more or less on the principle of services rendered or incidence of benefit.

**ANALYSIS OF SELLING AND ADMINISTRATIVE EXPENSES UNDER GOVERNMENT CONTRACTS**—Bidding, servicing, and other selling expense items which can be directly identified with particular contracts should be treated as direct charges to such contracts. Indirect allowable selling expenses are apportioned as between government business and other business on basis of:

- 1 Percentage of sales value. Percentage used is the ratio of the specific contract price to total sales value of all work completed within the period.
- 2 Percentage of cost value. Here percentage is found by dividing direct contract costs of a specific contract by total costs of all such work for the business as a whole.

**General administrative expenses** are to be treated in the same manner as selling expenses discussed above.

## SECTION 4

### THE COST DEPARTMENT

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## SECTION 4

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### THE COST DEPARTMENT

#### Basic Functions of a Cost Department

**OBJECTIVES OF A COST DEPARTMENT**—A cost accounting department is operated to compile cost data and to provide cost information in the form of reports and statements for all executives of a manufacturing business, viz. the directors, officers and major operating heads, also the supervisors of various groups including sales managers, factory superintendents, foremen, estimators and the like. The information produced by a cost department varies widely both as to subject matter and as to form of presentation according to

- 1 The person or executive for whom it is prepared
- 2 Whether it is a complete statement of facts in itself or is merely for inclusion in a larger project being prepared by another department
- 3 The type of cost accounting plan used

The modern conception of cost accounting is more than that of just recording the expenditures for labor, overhead and materials used in manufacturing products. Cost accountants usually agree on types and kinds of information to be gathered, the place of the department in the organization, and kindred subjects. However, the plan and place of the department vary among companies. These variations in practice frequently reflect the persuasiveness of some key executive or the lack of experience of the "deciding" executive in the benefits to be obtained from use of the most modern practice.

To justify its existence a cost accounting department must record and analyze all costs of production and report these data to the interested and responsible persons in such form that they are aided in directing and controlling the operations of the business toward its ultimate objective which is to earn a profit. Therefore, to attain the required result, a thorough understanding of how useful a cost department can be and of how best that usefulness can be achieved is essential. Moreover, it is significant that the selection of the best cost accounting system and of the best organization plan for the department is more difficult than the operation of the system and department.

Compilation of the needed information depends upon maintenance of adequate records. Information thus gathered through the records in turn constitutes the raw material in preparing routine and special reports and statements. This is illustrated in Fig. 1, showing a functional chart of the cost department.

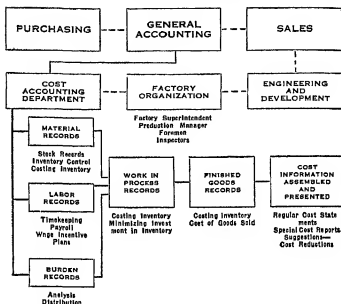


FIG 1 Functional Chart of Cost Department

**INFORMATION COMPILED BY COST DEPARTMENT —**

The principal types of information collected by the cost department and its subdivisions are

- 1 Cost elements (material labor and overhead) entering into costs of manufactured products
- 2 Overhead or expense of operating each department of the business
- 3 Analyses of causes as to why departments do not operate within their budgets and do not manufacture as economically as they should. These causes may represent excesses of many different kinds such as excessive scrap unexpected maintenance expense, and inexperienced direct labor
- 4 Operation of cost controlling accounts and all subsidiary and allied records connected therewith. These include perpetual inventories for raw material finished parts finished goods primary expense ledgers, expense distribution sheets, job order cost sheets or process ledgers etc.
- 5 Timekeeping data, where no separate department exists to handle this function
- 6 Compilation of payrolls

**PREPARATION OF REPORTS AND STATEMENTS —**

Since the data are compiled for use by operating supervisors, reports are prepared and issued periodically to the appropriate general and operating executives in analytical form so that they may manage most effec-

tively the activities under their immediate direction. Most of these reports are issued by the cost department directly to the interested persons, and the balance are prepared by the other departments under the controller after incorporating the cost department's data.

Other data are issued to **estimators** and others as occasion requires so that those activities may function effectively. Many of these data are compiled upon special requests as necessity arises rather than as a matter of routine timing.

**IMPORTANCE OF COST DEPARTMENT**—If a cost department is to prove its worth and justify its existence, it must stand ready at all times as an immediate source of information for control purposes. It is a service organization to the other departments of the business, it contributes nothing in itself of a constructive nature in earning a profit except as its service assists other departments to do a better job. If it fails in this duty, it does not serve its purpose and should be subjected to investigation and reorganization. On the other hand, a properly organized and well-administered cost accounting department operating a sound system ranks in usefulness with the most important service departments. The entire personnel of a business depends upon the cost department for information to decide questions and for information to guide destinies. Clearly, coordination of effort of the various departments depends largely upon prompt and correct cost information. Thus the work of the various department heads is made easier. To accomplish the desired result such coordination of cost activities with other departments should be definitely kept in mind at all times. Crusoe (N. A. C. A. Year Book, 1929) writes:

We consider the cost department as a service department with the production end as our customers. We try to take care of these customers by satisfying their demands for information by giving them the kind of figures that pay their keep and by developing new figures to give them the information which in our experience they can use most effectively.

### Place of Cost Department in Organization

**RESPONSIBILITY FOR COST DEPARTMENT**—Opinion has been divided among accountants, industrial engineers and factory executives as to the place of the cost department in the organization plan and the responsibility for its direction. In the resulting discussions there were two ideas:

1. Cost department as a factory department
2. Cost department as adjunct to general accounting department

**Cost Department as a Factory Department**—The advocates who maintain this position claim that the cost department is essentially a factory department, because it is engaged primarily in the maintenance of factory records and information and, therefore, should be responsible to the general factory management and divorced from the general accounting function. The theory that a cost department is organized for purpose of cost control supports this contention. However, the modern cost department may serve the sales, financial and general administrative departments as well and those departmental executives are loath to have their analyses compiled by a factory department.

**Cost Department as Adjunct to General Accounting Department**—Here the contention is that the cost department should be responsible to the general accounting department inasmuch as cost accounting is merely a phase of all accounting. Under this theory all accounting work is integrated and responsibility connected with it is centered in one head. An added consideration is that the values shown in the cost department compilations are controlled through the general accounting records. With the development of cost accounting techniques and the recognition of the usefulness of the reports and analyses, the need of an accounting specialist to supervise and direct the work has strengthened this argument.

**Conclusion**—For many years the consensus of representative manufacturing companies has been that a cost department should be directly responsible to the general accounting department or to some official connected therewith. The basis for this decision is clear. The cost department must be independent of the factory in order that its functions and activities are not hampered by factory instructions which may well be prejudicial because of the critical nature of the cost accounting work. A survey made some years ago showed a preponderance of cases in which the cost department was part of the general accounting administration where in only a small number of cases was it subject to the control of the factory manager. However, it should be recognized that the preference of many persons with regard to this problem of organization or procedure is directly related to the degree of satisfaction which they have experienced with the arrangement under which they work or have worked.

**RELATION TO CONTROLLER**—Fig. 2 sets forth the place of the controller in the general organization plan of a manufacturing company. It also shows the organization of his department. Compare this chart with Fig. 1 in which the cost department comes under the accounting department jurisdiction. Fig. 2 shows both these departments as subdivisions of the controller's function.

The recognition of the controller's importance and prestige, although gradual in development has reached the status that he must certify in that capacity to the accuracy and completeness of all reports filed with certain governmental offices including the Securities and Exchange Commission. This is in addition to the purely internal functions which he supervises. In fact his importance and usefulness are such that some companies make him a corporate officer responsible directly to the board of directors.

**Duties of Controller**—The Controllers' Institute of America has prepared a statement of specific duties recommended for performance by the controller and his staff in a typical manufacturing company. It is cited by MacDonald (*Controllership Its Functions and Technique*)

- 1 The installation and supervision of all accounting records of the corporation
- 2 The preparation and interpretation of the financial statements and reports of the corporation
- 3 The continuous audit of all accounts and records of the corporation wherever located



- 4 The compilation of production costs
- 5 The compilation of costs of distribution
- 6 The taking and costing of all physical inventories
- 7 The preparation and filing of tax returns and the supervision of all matters relating to taxes
- 8 The preparation and interpretation of all statistical records and reports of the corporation
- 9 The preparation as budget director in conjunction with other officers and department heads of an annual budget covering all activities of the corporation for submission to the board of directors prior to the beginning of the fiscal year. The authority of the controller with respect to the veto of commitments or expenditures not authorized by the budget, shall, from time to time be fixed by the board of directors
- 10 The ascertainment currently that the properties of the corporation are properly and adequately insured

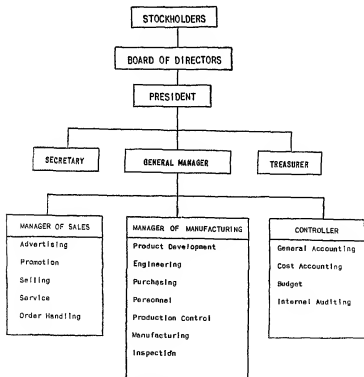


FIG 2 Place of Controller in General Organization Plan of a Manufacturing Company

- 11 The initiation, preparation and issuance of standard practices relating to all accounting matters and procedures and the coordination of systems throughout the corporation including clerical and office methods records reports and procedures
- 12 The maintenance of adequate records of authorized appropriations and the determination that all sums expended pursuant thereto are properly accounted for
- 13 The ascertainment currently that financial transactions covered by minutes of the board of directors and the executive committee are properly executed and recorded
- 14 The maintenance of adequate records of all contracts and leases
- 15 The approval for payment (and countersigning) of all checks promissory notes and other negotiable instruments of the corporation which have been signed by the treasurer or such other officers as shall have been authorized by the by laws of the corporation or from time to time designated by the board of directors
- 16 The examination of all warrants for the withdrawal of securities from vaults of the corporation and the determination that such withdrawals are made in conformity with the by laws and regulations established from time to time by the board of directors
- 17 The preparation or approval of the regulations or standard practices required to assure compliance with orders or regulations issued by duly constituted governmental agencies

**Controller and Cost Control Activities**—Cost control activities of the controller are described in "Functions of the Controller" (Policy holders' Service Bureau, Metropolitan Life Insurance Company) as follows

Prepare all cost data whether relating to production distribution or commercial activities and assemble cost information for use of the management in controlling expense and establishing selling prices. Cost accounting duties frequently include establishing cost standards and measuring actual performance against such standards also building up the cost of research and development projects

MacDonald explains the cost control responsibilities of the controller of a linoleum products company as follows

The controller, through the chief accountant is responsible for the cost accounting work of the company which includes not only the cost work, but control of inventories setting of burden standards the handling of factory records through the factory clerical sections and appraising plant, equipment and tools including the determination of depreciation

The cost sections of the different factories are known as the factory control sections and account for material and labor through a standard cost plan. The work of these sections includes the accumulation of actual expenses against the budget allowed daily where such records are required. The records furnished by the factory clerks, known as the factory clerical sections are controlled through the factory cost or control sections. The factory cost sections and clerical groups are responsible for the making up of the original records within the factories, the handling of time cards for the central payroll department at the home office where earnings are made up and checks are made out for payment of wages. They also handle employment information for the production executives and such other special information as is required by the factory superintendent or a foreman within an operating department. These sections are also responsible for perpetual inventory records and the checking of the physical against the perpetual and the determination of variances for material and labor from standard for factories and operations

The factory cost section keeps detailed perpetual inventory records which are controlled by the records maintained in the inventory control section at the home office. Cost estimates required for price fixing on specialties and other commodities are determined by these sections and the cost standards for material and labor are built by the factory control sections at regular intervals. Cost estimates on contracts where such work is a part of the sales division are estimated by the sales organization subject to the check through the records later furnished by the controller when the contract is completed.

The inventory control section at the home office is responsible for records which give the controller, the cost sections and the production planning and control department information by means of which inventories can be properly regulated and controlled.

The burden standard section at the home office accumulates the expenses by operations branches and staff departments of the company, allocates and distributes burden and determines the standard burden rates for the various manufacturing and distributing operations, commercial expense and for each product produced or traded in by the company. This includes products purchased from outside manufacturers and sold by the different sales divisions.

Present recognition of the importance of the control function is one of the primary reasons for the increased stature and responsibility of the controller. The latter performs his part in the control function most effectively by providing factual data in report form to the operating executives. Each grade of worker, foreman and executive needs facts as guides for performance. The nature of control reports varies with the needs of each grade of executive and with each type of control responsibility. (See Section 1 on Reports, Analysis and Control.)

**JURISDICTION OF CONTROLLER**—A large company may have so many employees in the accounting function that they are grouped into many departments and sections, each under an executive supervisor. For example, one large company requires almost 200 people in its vouchers payable work and groups them as a single department under specialized supervision. Even in comparatively small companies employing only a few persons in accounting work, the duties are divided among the personnel so that each specializes in one or more types of work. As the number of employees increases the personnel is grouped, according to work, for easy administration under supervisors who are specialists in each particular field. This is illustrated in Fig 3 for a company of medium size.

**Cost Department**—The cost department, with its subsidiary functions, frequently is the largest department and may require even more subdivision than shown on Fig 3. The relation of the cost department to the other departments responsible to the controller, as indicated on Fig 3, is outlined in the following paragraphs.

**General Accounting**—This department performs numerous accounting functions and coordinates all accounting work and data as indicated in the following list of its most important duties:

1. The handling of all detailed accounting papers not passing through or recorded by the cost department, such as purchase invoices, sales invoices, general journal vouchers, cash receipts and disbursements, etc. The cost department receives memoranda of all such transactions affecting the cost of production and the expenses of operating, the various

departments of the business. Detailed accounting papers handled by the cost department are summarized by it and the summaries frequently in journal entry form are passed to the general accounting department for entry in the appropriate books of account.

2 The maintenance of the controlling books of account such as the general ledger and the accounts receivable and other ledgers and of the

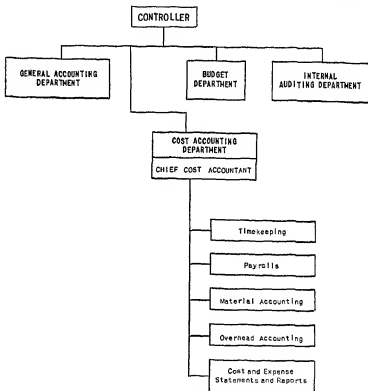


FIG. 3 Subdivision of Cost Functions under Controller

books of original entry such as the vouchers payable register, general journal, etc. The detailed stock records are likely to be maintained in other departments as previously recommended, but are nevertheless a part of the books of account and under functional accounting control. The various accounting papers mentioned in the preceding paragraph and the summaries of cost and expense factors prepared by the cost department are recorded in these books of account.

3 The plant asset records Depreciation charges on machinery and equipment are accumulated from these records and reported to the cost department, and the latter in turn reports data for repairs additions and disposals originating in the factory cost accounting records

4 The preparation of balance sheets and profit and loss statements Data supplied by the cost department are vital to preparation of these statements e.g. cost of sales inventory transactions, etc

5 The compilation of sales and other control statistics Costs of products sold and many data for these and other statistical analyses originate in the cost department

6 The compilation of tax statements Tax and other government statements require data to be prepared in certain formats and the amount of taxes paid depends, in part, upon the proper treatment of expenses in accordance with the law The accounting departments must observe those regulations in their day-to-day work

The above definitely indicates the close relationship between general and cost accounting, neither activity can carry on its work without the closest cooperation of the other

**Budgeting**—This function has been defined as translating the plans for the business into terms of money, and then consulting with the executives in the shaping and modification of those plans so that the objective of the business earning a profit, may be attained While budgets are usually planned for a year, conditions beyond the control of the business change, and even the best of plans often get out of control through negligence

Hence, after the plans and budgets are approved the budgeting personnel has the responsibility of continuous comparison of actual results with the budgets and the preparation of analyses and reports to explain the discrepancies If results are more favorable than anticipated the causes should be determined to take definite advantage of them and to make repetition possible, if results are unfavorable the causes are sought for determining means of corrective action Most of the data for these comparisons originate in the cost department and many of the causes for the variances can be identified While the cost department can await requests for such analyses of causes of variances, it should take the initiative in reporting them

**Internal Auditing**—The task of checking the accuracy of the records is a function of the controller This work of internal audit and scrutiny is made easier if a proper system of internal check has been developed According to Thompson (Accounting Systems), the basic principle of a system of internal check lies in a subdivision of labor in such a way that "no one person in an organization should be in complete control of any important part of the business operations" In this way one person checks another thus insuring accuracy and fidelity The fundamental purpose is to minimize fraud through collusion among employees it is therefore part of the controller's function to provide protection against this hazard through the organization of a system of internal check which in turn makes the task of internal auditing easier The following duties compose the field of internal checks

- 1 To see that the company receives all revenues which it should receive

- 2 To see that the company makes no payments which it should not make
- 3 To see that no cash securities merchandise, equipment or any properties belonging to the company are stolen in so far as this can be prevented by establishing records of personal responsibility and by establishing proper internal checks and safeguards
- 4 To protect so far as possible through records and tax and insurance procedure against the dangers of physical destruction of property impairment of title, and claims for personal liabilities
- 5 To see that all receipts and disbursements are charged and credited to the proper accounts

In providing such protection, the internal auditor must depend upon

- 1 Records of transactions
- 2 Records of accountability
- 3 Internal check system
- 4 Files of information
- 5 Insurance and tax records
- 6 Mechanical protective devices

In this way the accounting records are made to yield a maximum of usefulness for the purposes of information, protection, and control

#### **COST DEPARTMENT AS SOURCE OF INFORMATION—**

A properly organized cost department must cooperate with the other departments of the business to secure satisfactory results, not only to insure cordial acceptance of its reports but also to encourage the other departments to be eager to supply data for the cost department's use and analysis. Thus all departments are dependent upon each other, and the cost department must cooperate with the other departments responsible to the controller to the same extent as it works with the general management sales, and manufacturing divisions. While the department must be ever watchful for ineffectiveness in the operating departments, it must recognize that the executive in direct charge of any activity is entitled to receive the information before his superior, particularly if the condition is unfavorable. The capable operating executive by taking immediate corrective action enables the cost department to report with satisfaction the improved results rather than being obliged to report a continuing unsatisfactory condition. Careful consideration in handling such matters leads to improved interdepartmental relations.

**General Management, Officers, and Directors—**Executives of well-managed companies are guided in their decisions by facts and suggestions presented by the cost department. These frequently arise in the cost department's daily handling of the many detailed operating figures which show the weaknesses and strengths of the current methods of doing business. Such suggestions if acted upon are an aid in

- 1 Controlling day to day activities
- 2 Effecting cost and expense reductions
- 3 Establishing broad policies, such as those relating to plant improvement and enlargement

**Sales Management—**The cost department furnishes much information of use in planning the sales activities. Among these are

- 1 Costs or estimates of costs for pricing products
- 2 Suggestions for placing emphasis upon selling those products which

are the most profitable or advantageous under the then current conditions

- 3 Choosing the most effective and least costly selling methods and channels of distribution

These data have become recognized as of increasing importance to sound sales management, and, when properly used in sales planning and then accompanied by sound expense and sales controls the historical or post mortem analyses of expenses and of margins and profits on products sold become of less importance although they comprise the most frequent routine reports to the sales managers

**Product Development**—Oftentimes this function in metal working industries is consolidated with the engineering department. It is usually a separate entity in other industries. It plans, approves, and often initiates the development of new products and changes in models. These ideas are checked as to economic possibilities from the cost viewpoint by the cost department's personnel or from its data.

**Engineering**—This is the function charged with the introduction of changes in factory layout, new manufacturing plans, and new equipment including the items frequently referred to as gadgets, i.e., small tools of various types and other facilitating devices usually intended to save labor or improve quality. The engineering and cost departments work hand in hand. While the engineering department or some other factory department usually initiates new developments, the profit outcome of developments and changes are estimated or checked by the cost department based upon its past experience and current information.

**COST DEPARTMENT AS RECIPIENT OF INFORMATION**—The relation of the cost department to the above mentioned functions and departments is primarily to supply data to them either as a routine or upon specific requests. While a similar relationship exists with all other departments, there are some departments, primarily in the manufacturing division, in which the situation is reversed. The flow of operating data from these departments to the cost department and from the cost department to other departments is illustrated in Fig 4.

**Purchasing**—Although apparently removed from the activity of cost finding the purchasing agent's services are vital to the successful operation of a cost department. The cost department finds that total costs (material, labor, and overhead) vary in many cases because of fluctuations in the grades, qualities, and sizes of materials used. Based upon actual conditions, a cost department is able to form with the purchasing agent a liaison that works to the distinct advantage of the company. Labor costs increase or decrease with the degree of hardness of steel or with the grade of chemicals used, and exact specifications must be written in collaboration with the engineering department for the purchasing agent to meet and follow.

In a business where price fluctuations of raw material are frequent, the purchasing agent must keep the cost department advised of important changes in market prices. Upon receipt of this information the cost department may compute new product costs and transmit them to the sales department for its guidance in accepting orders, particularly





- 1 The determination of the quantities of raw materials to be maintained in inventory and of the quantities of finished products and component parts to be produced and carried in inventory
- 2 The determination of the most economical quantities of materials to be purchased and of products to be produced
- 3 The determination of the most economical routing for processing orders
- 4 The compilation and issuance of the standard production analysis records for the materials required for manufacturing each product and for the most advantageous routing and scheduling of the parts and products from operation to operation. These analyses comprise the formulae for the cost department in building the costs of products

The dependence of the production control department upon other departments for much information on details as to the when, what, where and how to manufacture is illustrated as follows. The product development, engineering, sales and cost departments must approve the materials and other provisions for manufacturing the products before the standard production analysis records mentioned above can be compiled and distributed. Then the production control department, being in the best position to coordinate this information, prepares and distributes the appropriate instructions and later is responsible for directing production in accordance with those standards. Its skill in utilizing these approved methods can be measured in the actual costs of production, the amount of inventory carried, and in other ways as reflected in the accounting compilations. Its continued usefulness is also seen in the many ways available to it such as suggesting changes in tooling, materials, machines, routing, etc. because it oversees the daily factory operations, and is aware of the deficiencies. Moreover, bottlenecks and all other kinds of factory wastes are hindrances to attaining optimum control performance, and hence are also subject to the same constant scrutiny for improvement. The production control department also serves the cost department, for example, with information regarding the orders to be produced as a basis for setting up the cost accounting and the expense accounting records. In addition, the production control manager supplies the cost department with estimates of the capacities of each production center for calculating the standard overhead rates.

The modern production control department also includes and directs these activities: storeskeeping, time study or rate setting, dispatching which is frequently consolidated with timekeeping, and internal trucking. The first three of these four functions are particularly important in relation to sound cost keeping.

**Storeskeeping**—The satisfactory operation of any cost accounting department depends to a large extent upon the performance of the storeskeeping personnel. Materials, representing cash and often constituting a major portion of production costs and of working capital, are under their direct supervision. This includes both the physical phase of custody of materials in stock and the clerical phase of stock record maintenance. The cost department requires from the storeskeepers

- 1 The reporting of all quantities of materials withdrawn from stock
- 2 The job numbers, operations, processes or departments to be charged for materials withdrawn

- 3 A record of finished parts and products delivered to stores from production
- 4 A record of returned materials with job numbers, operations, processes or departments to be credited
- 5 A complete report of scrap delivered to stores from production
- 6 The value of each transaction

Usually finished products and supplies are kept in the storerooms until required, although some stocks of raw materials and parts frequently are kept on the production floors rather than in centralized storerooms. Storekeepers have control of all materials regardless of their location so that they are properly handled to prevent waste, damage, and pilfering, and so that all transactions of receipts or of issuance and usage are properly reported. Therefore storekeepers must realize the importance of material requisitions, returned material credits, bills of material, summary material sheets, and other papers involved in the system and needed by the cost department in charging and crediting the inventory, work in process, expense, and other accounts.

Some companies locate their **stores records** in the storerooms where the materials are located. This is not advantageous in the operation of a modern production control program. The better practice is to locate these records in the control office, although under some circumstances the records for supplies may well be located in the purchasing department and those for finished products in the sales department. Practices among companies also differ with regard to where and how the requisitions are priced and the other working papers prepared for charging and crediting the inventory and other accounts. The preferred practice is to enter the prices or values upon the stock records so that the clerical work of evaluation may be completed when the transaction is being recorded.

Because the stores records are a part of the **general financial records** of the company in that they support and record the details of the inventory accounts, the financial aspects of these records should be under the functional control of the cost department and controller regardless of their location. This is necessary to insure their maintenance in order to supply the essential financial data. This interest extends to the physical phases also to insure that materials are adequately protected while awaiting usage and that all transactions are covered by adequate reports. The cost department, however, is not concerned in the details of the planning and scheduling aspects of materials control and storeskeeping.

**Time Study and Rate Setting**—Well-organized concerns know what the labor cost should be for producing each unit of production. Labor rates are graded for the various classes of work under current business practice, and standard time allowances are established for each operation. Combining these two factors determines the standard cost. Labor rates are established as the result of detailed studies of the skill, experience, physical requirements and other factors required for each operation, and the time standards are based on studies of the required men, operations, and machines, and the conditions under which work is performed. This latter procedure is usually known as time study and is primarily concerned with establishing the standard as the reasonable

time for performing a job. When evaluated by applying a labor rate the money value of standard cost is obtained.

When a labor time standard is once established a change is not made unless a change in method or operation takes place. If new materials are used or new methods of performing an operation are adopted, ratemakers establish new standard times. Therefore the duty of rate setters is to maintain up-to-date time standards for the various operations and work duties to be performed. While the time study men work independently of the cost department, their results and findings must be reported promptly to the cost department in order that costs for operations and products may be recalculated, that up-to-date costs may be available for pricing of products, and that the cost department may be alert to variances of actual labor costs from standards.

**Dispatching and Timekeeping**—Dispatchers are liaison clerks between the production control office and the production shops. Their duty is to release orders to the shops, giving the "go ahead" to proceed with production. However, these clerks also check to see that orders are processed on schedule, in the standard methods and within the standard times, and are moved on to the next operation. This requires maintaining a close contact with the work as it proceeds.

The compilation of accurate payrolls requires accurate timekeeping and timekeeping for proper cost records requires each worker's time to be divided between productive work and nonproductive work. The former must be reported in terms of what and how much has been produced, including the units passed and defective, and the latter classified according to the expense accounts to be charged. Remarks must be entered on the time reports regarding unusual happenings affecting production costs. In this work the timekeepers act as the cost department's labor representatives in the plant. This work, like dispatching, necessarily requires constant and close contact with the work as it proceeds through the shops. Although the timekeepers are generally located in the shops, they are in most plants responsible solely to the cost department, in some plants they are responsible to the foreman or to the superintendent.

Although many plants have separate timekeeping departments, some have discovered the advisability of combining dispatching and timekeeping. In such cases each shop clerk performs both functions under the direct control of the production control department and under the functional control of the cost department with reference to the timekeeping activity. This practice of combining dispatching and timekeeping usually is not only less costly but also more satisfactory to the cost department because the dispatching portion of the clerks' duties compel their being more familiar than the usual timekeeper with all details regarding actual production. Thus the information recorded for the cost department is likely to be more accurate and complete than if compiled by a clerk performing timekeeping duties only, provided the cost department prescribes the data it requires and the production control department cooperates thereon.

**Foremen**—There is a difference of opinion in practice between cost accounting and factory executives regarding the cost duties of a foreman. In some companies, foremen play a major role in collecting time, pro-

duction, and cost data in form of reports statistics and other detailed information. In such instances foremen act as clerks and timekeepers, and sometimes as dispatchers as well, and perform the duties previously described under those headings. Most companies believe foremen should not perform clerical duties and should limit their activities to serving as operating executives who have no part in cost finding other than observance of specified rules to manufacture products in accordance with standard practice and within standard allowances.

**Inspectors**—Inspectors play an important part in the operation of a cost department. Upon information furnished by the inspectors' reports (1) the quantity of good product is determined (2) the quantity of scrap or waste is established and (3) the relative efficiency of production departments in manufacturing products of standard quality is measured. These data also serve as a guide for determining the standard scrap allowances for each product and as the base for calculating the cost of, or loss on excess scrap. Moreover, the inspectors' reports frequently are the bases for charging the responsible department for the excess costs of reworking unsatisfactory production. In order that the cost accounting department receive full information inspectors' reports should be complete as well as accurate.

## Personnel of Cost Department

**SELECTION OF PERSONNEL**—Proper personnel to operate a cost system is just as important as the system itself. A weak system with a strong personnel may survive, while a strong system with a weak personnel is likely to fail. Persons selected to operate the system should possess a sound technical knowledge of accounting procedures, not only of cost accounting but of general accounting as well. They should possess sufficient vision to enable them

- 1 To trace the effect of changes in cost on company operations
- 2 To detect errors and irregularities that may creep into the records
- 3 To visualize the various manufacturing operations

In order to minimize friction it is advisable to list the personnel of the cost department then titles and duties. The following is a suggested outline adapted from Dohi, Inghram, and Love (Cost Accounting)

1 **Head of Accounting Department Called Auditor or Controller**—Duties include the supervision of the workings of the department approval of all important transactions as entered on the records and the signing of all statements before submission to the various officials of the enterprise.

2 **Factory Ledger Clerk**—Where a separate factory ledger is operated, it is handled by the factory ledger clerk whose duties are similar to the general ledger clerk. At the end of each cost period the general and factory ledger clerks have the duty of reconciling the interlocking accounts of the two ledgers.

3 **Balance of Stores Clerk**—Where perpetual inventories are kept in the cost department, this clerk has charge of the stores ledger and his duties include the entry of goods received the entry of goods issued and the balancing and reconciliation of the stores ledger with the control account.

4 **Cost Clerk**—In a job order system this clerk has charge of the cost sheets, the entry of material and labor charges thereon, the calculation of the factory overhead applicable and the computation of the cost of the finished product when completed. These duties are modified to suit process cost or standard cost systems.

5 **Time Clerk**—This clerk has charge of the recording of time by the workmen.

6 **Payroll Clerk**—This clerk has the duties of gathering the time cards, computing the workmen's pay, entering the necessary data on the pay rolls and preparing the payrolls for entry.

**ORGANIZATION OF THE COST DEPARTMENT**—The cost department's organization varies with the size of the company. A large manufacturer must divide the cost accounting activities into more groups than shown in Fig 3 for convenient administration, while a small company has no distinct groupings. In fact, in very small companies it may be difficult in actual operation to distinguish between the cost accounting and the general accounting, personnel and activities. In the small company, the division of duties is likely to be determined largely by the skills and experience of one or two persons and all detailed work is organized around that personnel. Nevertheless it must be recognized that the same kind of steps and activities are performed by the small company as by the large. One person in a small company supervises more kinds of activities than an executive in the large unit, and in a very small unit, one person may supervise all activities or may actually perform all the work involved in several activities, for example, from timekeeping and payroll work to computing the cost of sales amounts.

The duties of the personnel also vary depending upon whether the cost plan is of the "actual" or "standard" type. Moreover, the details of organization depend upon how the activities associated with cost accounting are distributed among the operating departments. Assuming the cost department of a medium-sized plant to be organized as shown in Fig 3, the duties of the various personnel are described below.

**Duties of Chief Cost Accountant**—An executive in charge of a cost department is common to manufacturing companies and while his official title may vary as between cost accountant, factory accountant, works accountant and the like, his duties are more or less uniform. The chief cost accountant's duties include

- 1 Supervision and coordination of all details in the collection of cost figures.
- 2 Presentation of cost and expense information developed in the cost department.
- 3 Study of the cost accounting plan and the resultant reports to the end that they may become of increasing value in assisting the operating executives to manage and control their departments more effectively.
- 4 Contacting the executives of other departments determining the needs and desires of these executives and formulating plans for dissemination of cost data.

James states (N A C A Year Book, 1930)

I have had many shop superintendents and managers say to me that a plant accountant or works accountant was worth his weight in gold who

could give to the controlling head of the plant wise counsel based upon businesslike interpretation of his own figures.

In short the successful working of a cost department depends upon the ability of the chief cost accountant to analyze to determine the needs, and to present pertinent information to the management of the business.

The chief cost accountant's most important technical qualification is his ability to keep his cost system up to date as cost accounting techniques develop and change to produce more and more useful information for those operating executives. He should always keep in mind that the routine operation of a cost accounting plan requires less ability and technical knowledge than the improvement of the plan and the selection of appropriate new practices.

**Duties of Cost Supervisors and Clerks**—Upon the cost clerks' shoulders rests the responsibility for examining and collating the many details of cost and expense information which are passing daily from factory and other departments to the cost department. In the stress of work, errors creep in, mistakes in production recording, in pricing, in materials, all of which must be detected to avoid erroneous cost results. Moreover, all cost clerks should have a basic understanding of accounting principles so that they can prepare their reports and data in proper form for entry in the accounting records and understand the value and effect of the work produced by them. Obviously the greater the responsibility of the clerk or supervisor, the more important it is that he be well trained in accounting.

The cost clerks' duties may be described as routine with the qualification that the routine offers many variations so that constant thought is required. More specifically one duty of the cost clerks is to post or distribute information regarding the consumption or use of materials. Labor charges, likewise, must be allocated to their respective jobs, operations, processes, departments, or expense classifications. Superimposed upon material and labor charges, burden must be distributed on some predetermined basis. Finally these amounts must be accumulated for reporting to management and for recording in the books of account.

Cost clerks should be familiar with operations of a plant, the materials used, and the nature and use of finished products. To this end, cost clerks should be encouraged and required to visit the plant frequently to learn its work, organization and problems. In fact all new clerks should be taken on a tour of the plant before or shortly after their first acquaintance with the cost accounting system.

The goodwill which cost supervisors can build for themselves is illustrated by the comments in a recent house organ concerning the company's controller:

Our controller "Diminutive Tommy" is perhaps the best known to the mills of any of our New York associates because he spends much of his time at East Douglas consulting with our various executives, obtaining the data and details for use in the various activities of the organization and in the research and study that must of necessity be continually followed if we are to keep abreast of the times.

This is particularly important for the senior accounting supervisors and executives who must supply the vision for improving their own cost plan and reports. When comparing their methods with what they

read about or see in other companies, they must be able to select the best of modern practices for their company. On the other hand, it is not an easy task for the supervisor to institute changes and improvements. He must keep the present system operating at top efficiency while devising and installing the new system, and then must face all the problems and kinks of bringing the new system to top efficiency. This requires time and patience.

**RATIO OF COST CLERKS TO EMPLOYEES**—The question of the ratio of cost clerks to factory employees frequently arises in studying the organization of a cost department. A generalization cannot be given because of the many variables, e.g. the type of industry and of products, the plant facilities, the dispersion as previously described of the detailed work of compilation and reporting of data among different departments in the controller's group and in the factory, the variety of details compiled and reported, the ability of the cost department personnel and the needs and demands of the management for data and reports. Other very important factors are the type of cost system, and the ability of the supervisors to install the most efficient methods, either manual or mechanical.

One survey, based upon tabulations of the number of persons engaged only in the compilation of costs of products, also disclosed that the ratio of employees engaged in cost accounting to factory employees decreased as the size of the company increased. Companies employing up to 600 employees averaged one cost clerk to 80 employees, while in larger companies one cost clerk to 150 employees was common. This difference in part is due to the presence in large companies of many detailed transactions of one kind which can be handled en masse and in part to the more efficient methods found in large departments under specialized direction. Another important factor is that while the large company must employ more persons than the small company to manufacture one given product (the quantities produced are larger) both companies probably compile the same product cost the same number of times. Representative companies reported as follows:

	No of Cost Clerks	Total No Employees	Total No Employees for Each Cost Clerk
Metal plant—varied products (jobbing basis)	9	1 400	155
Rubber tires and tubes	22	3 293	149
Automotive parts	3	350	116
Food containers	5	600	120
Vacuum cleaners	4	300	75
Brass works	10	1 200	120
Pharmaceutical products	16	4 600	281
Gasoline refinery	4	200	50
Salt manufacturing	5	300	60

**COST OF COST ACCOUNTING**—The expense of maintaining a cost department is a subject which causes periodic discussions in every manufacturing company. This question of accounting expense is one, however, that is applicable to general and all other accounting and clerical activities as well as to cost accounting. The fact that it is a considerable amount in all companies was shown in a compilation by

Sanders (NACA Year Book 1928) The figures, however, showed a wide range and it is a question whether they possess any real significance. A more recent study was made by Sieplein (NACA Bulletin vol 19) who states

The expenditure incurred in figuring costs has been found by many companies to be less than  $\frac{1}{4}$  of one per cent of sales. In other words it costs only 25 cents to obtain true knowledge of the cost of products for a sale amounting to \$100.

A tabulation made some years earlier shows the cost of cost accounting of one company to be about 55% of direct labor but by the introduction of some economies the cost dropped to 43%.

### Organizing Cost Reports and Forms

**PROMPTNESS OF COST REPORTS**—Even if cost reports are accurate and of useful types, they lose value to the operating executives unless they are prepared and distributed promptly, in time for inefficiency to be controlled. The emphasis in modern management's philosophy is upon planning for the prevention of inefficiency as far as possible. The controller's responsibilities for the translation of management's plans into budgets and for the preparation of cost and other reports comparing the actual results with the budgeted or standard expectations are two of the steps in preventing and controlling inefficiency. However, the controller's responsibility carries further, his work must be completed quickly, so that the reports are timely which means that they must be received by each operating executive while the activity is still in process or vivid in his memory, or in time to prevent a continuing action that would be less than satisfactory.

The experience of strong companies demonstrates that frequent tabulations are essential in eliminating inefficiencies quickly before they reach critical proportions. The cost department must also learn that only **summary figures** are necessary so long as operations are efficient but the routine must be established by which the summaries can be expanded into detailed reports if and when inefficiency increases. Then, as soon as control has been attained, the summary reports are instituted and details eliminated. Proper timeliness is illustrated in the following examples of reports.

**Reporting Labor Efficiency**—The time study function establishes labor time standards for performing each operation. Actual labor time and pieces produced are reported by the timekeeping and dispatching function so that the efficiency of each worker and each department may be measured. Each day, if necessary, a report can be made to foremen and factory supervisors of the efficiency of each worker or each group of workers under their direction. These reports may be very detailed or in summary form according to the needs of the moment. For example details reported may include the efficiency expressed as the percentage of actual production to that expected, the ratio of indirect to direct workers, and the hours lost or wasted by inefficient workers or as a result of the workers waiting for materials or tools or for machines to be repaired, the latter wastes being a measure of the production control



effectiveness for which foremen are frequently blamed although not responsible

The production supervisors in many plants receive such reports each afternoon covering results of the previous day. Thus weaknesses are disclosed to foremen without their having to handle many papers, and before the operation involved is forgotten. Some plants endeavor to obtain the same result by requiring foremen personally to review and approve each worker's time card and production report. This and similar measures are poor makeshifts and actually may be very costly in the demand upon the foremen's time to handle every time card and make the comparison between expected and actual production.

**Reporting on Overhead**—Overhead reports for each producing department and expense reports for sales and service departments are essentials in every well-managed organization, but often are compiled so late as to be almost useless. For example, the monthly reports compiled in one company having many plants with several hundred production centers and service departments, are not completed and distributed until after the twentieth of the month following and sometimes later. This is considerably later than is good practice. The cost department not only should issue these reports by the eighth of the month following but at times should issue **weekly tabulations** of actual and budgeted expense for the items which are under the supervisors' direct control.

With proper organization a cost department finds frequent **tabulation and distribution** of data not only of greater value to the operating supervisors but also of convenience to itself. Most cost departments summarize the hundreds of working paper details once each month after the close of the month to which they apply. This results in a peak of work and oftentimes much overtime as well as delay in starting the new month's routine work. Frequent summarization or reporting, such as daily for labor data and weekly for expense and overhead data, saves the month end burden and establishes a favorable reputation for the cost department's ability to supply data which are useful and timely.

**Reporting Product Cost Data**—The sales department is naturally dependent upon the cost department for product cost data. Some cost departments never submit such costs unless requested by the sales department. Thus the time when these data may be of real importance is often passed and the company suffers. The cost department is handling daily the details of all elements of cost and therefore knows when changes in cost are occurring. It should take the initiative of reporting promptly such changes as are important, either upward or downward to the sales department.

**ELIMINATING USELESS REPORTS**—Constant watchfulness must be maintained to employ more efficient methods and to eliminate unnecessary work, particularly reports which do not "pay their keep." Ways and means are frequently found to enlarge the activities and improve the service without increasing the expense. This leads Papworth (N.A.C.A. Bulletin, vol. 9) to state:

It pays periodically to inventory the reports emanating from our department and check them against their actual usefulness to the people to whom we are furnishing them. If they are not much used ask for permission to cut them out or cut them out without saying anything and watch what happens.

Along this same line too many reports are being typed or copied long hand where the original working papers in pencil if neatly done would serve just as well. I have seen several nice little stenographic copying jobs discontinued after a careful study of the real utility of their product. Another advantage of using the original papers is that the time of copying is saved and the data reach the place where they can do some good just so much quicker.

If we are to be held responsible by management for the cost of operating our departments and we shall be sooner or later let us show management what some of the practically useless things we are expected to do actually cost. I have seen managers rail for the cost on a complicated assembled product right off the griddle reflecting last week's labor figures and today's material costs. The cost department would wail feverishly burning midnight oil in some cases and the result would be a plus or a minus of 2 or 3 cents on a product costing around \$20 as compared with the cost used in last month's cost of sales.

Needless requests from too many sources have frequently added considerably to the cost accounting expense. Good practice demands that requests for special information from the cost department be held to a minimum. Such requests should clear through one person vested with authority to turn down what appear to be unreasonable and unnecessary requests although the person making the request will frequently withdraw it if advised of the time and expense required for compilation. On the other hand care must be taken that worthy requests are not discouraged.

**STANDARDIZATION OF FORMS**—Reports which are to be presented to executives and operating men should be attractive and easily understood. Operating men and management do not have the accountant's facility for interpreting figures and often miss the meaning of a statement unless it is presented in the most obvious manner possible. It may even be necessary for the designer of a report form to employ nontechnical language particularly in the early days of a system's installation. For example on a departmental overhead report for use by a foreman it may be better to use the phrase "you should have spent" instead of "budget," at least until the foremen have been educated to understand the nature and significance of a budget. Forms should be kept to a modest size with subject matter as restricted as circumstances allow. Standardizing of forms used has the double advantage of effecting economies and of speeding up the preparation of statements. Thus Papworth reports (N A C A Bulletin, vol 9) a saving of 50% on printing and stationery by using stock sizes elimination of useless forms etc. Knuff reports (N A C A Bulletin vol 14)

Standardizing on form sizes facilitates the compilation of reports as well as the typing and filing of such reports. We have recently changed all our cost sheet forms from 11 x 17 to 8½ x 14 the change effecting a reduction in the cost of forms to the extent of 35% to 40% a reduction in the time of typing and ditting of approximately 25% and above all the convenience in handling a cost portfolio of an 8½ x 14 size as compared to an 11 x 17 brief case size permits our busy executives to utilize their travel time in digesting costs which naturally leads to better and more efficient management.

**Designing Forms**—Because of the nature of its work, the cost department is frequently called upon to design new forms or to redesign old forms. The principles set forth below apply equally to the design

of report forms and to that of accounting and other records. A review of the forms in use with illustrative entries is helpful whenever new or revised forms are contemplated as well as when reprinting. Frequently it is found that some spaces are not used while other spaces are used for purposes not intended because no space was provided for the specific item.

The exact design depends on many factors, that is whether the forms are prepared for use manually or designed to be used in connection with mechanical equipment. Specifically, the following suggestions are made by Heckert (Accounting Systems)

- 1 Know definitely what purpose the form is to serve
- 2 List all information which the form should carry, omit all unnecessary information
- 3 Determine relative importance of each type of information and amount of space each requires
- 4 Select style and size of sheet or card which is most convenient economical and practical, or in case mechanical equipment is used size and style of form suited to equipment
- 5 Arrange positions of information in manner most convenient for recording and for subsequent reference and use
- 6 If form is for machine use make sure that it works efficiently in the machine for which it is designed
- 7 Omit horizontal lines from machine forms
- 8 Note carefully preceding forms from which information is taken and succeeding forms to which it is transferred so that convenient arrangement of data and multiple copies can be used to eliminate any unnecessary steps
- 9 Select colors which are useful in identification and readily legible
- 10 Place necessary instructions on forms to insure their proper use
- 11 Check carefully motions of clerks or machine operators in use of form to eliminate lost motion through imperfect arrangement
- 12 Carefully test all important forms by actual use before large quantities are printed
- 13 Secure criticism of clerks and operators as result of tests

**Arrangement of Material**—The information on the form must be arranged so that it is as clear, concise and simple as possible. In appearance the form should be pleasing and should be so designed that a minimum of training is required in its proper use. The title and identification number ordinarily appear at the top. All column headings should be as clearly descriptive as possible. The ruling and spacing should provide adequate space for legibility.

When a form is to be filled in on the typewriter, it should be so designed that once it is adjusted to the proper position in the machine, the writing will fall automatically in the proper spaces without further adjustment. Proper margin space must be provided for any form adapted for use on a typewriter. Forms for other machines must of course conform to the mechanical requirements of the particular machine in question.

**Selection of Paper**—The quality of paper chosen for the various forms must depend upon

- 1 Importance of the form
- 2 Amount of handling which form must withstand

Each cuts without waste from standard sizes used by all printers			
Size of form	Cuts Without Waste from Standard Sheet Measuring	Number Obtained from Single Standard Size Sheet	Number of Single Forms Obtained from One Ream (500 sheets) of Paper
2 1/4 x 4 1/4	17 x 22	32	16M
2 1/4 x 8 1/2	17 x 22	16	8M
3 1/4 x 4 1/4	17 x 28	32	16M
3 1/4 x 8 1/2	17 x 28	16	8M
3 1/4 x 17	17 x 28	8	4M
4 1/4 x 5 1/2	17 x 22	16	8M
4 1/4 x 7	17 x 28	16	8M
4 1/4 x 11	17 x 22	8	4M
4 1/4 x 14	17 x 28	8	4M
4 1/4 x 28	17 x 28	4	2M
5 1/4 x 8 1/2	17 x 22	8	4M
5 1/4 x 17	17 x 22	4	2M
6 x 4 1/2	19 x 24	16	8M
6 x 9 1/2	19 x 24	8	4M
6 x 18	19 x 24	4	2M
7 x 8 1/2	17 x 28	8	4M
7 x 17	17 x 28	4	2M
8 1/2 x 11	17 x 22	4	2M
8 1/2 x 14	17 x 28	4	2M
8 1/2 x 22	17 x 22	2	1M
8 1/2 x 28	17 x 28	2	1M
9 1/2 x 12	19 x 24	4	2M
11 x 17	17 x 22	2	1M
12 x 19	19 x 24	2	1M
14 x 17	17 x 28	2	1M
Bond and ledger papers are obtainable in 17 x 22 17 x 28, 19 x 24 22 x 34, 28 x 34 24 x 38			

FIG 5 Standard Form Sizes

In this connection Heckort (Accounting Systems) states

The quality of paper selected must conform to the purpose which the form is to serve. A daily report handed to a foreman requires only an inexpensive bond paper, but a record of registered bonds of long term requires a good quality of ledger paper. Again if frequent erasures are necessary on a form it is poor economy to use a cheap paper stock.

Paper of different colors can be used to great advantage to distinguish the copies of multi copy forms or to distinguish different sections of related records. Colors should be selected on which the printing or writing will be legible.

The size of the form should be determined by the following factors

- 1 Contents of the form Ample space should be allowed for making entries without waste
- 2 Size of binder folder or filing unit Binders and filing devices are built in standard sizes It is usually possible to design forms to conform to such sizes Nonstandard devices are always more expensive
- 3 Proper size to cut economically from standard sized sheets Flat papers are manufactured in standard sized sheets and forms should be designed so far as possible to cut without waste from such sheets

Fig 5 shows the dimensions of individual forms which can be cut without waste from standard flat papers

**Printing Specifications for Forms**—In order to avoid confusion and misunderstanding, a carefully drawn copy of the form should be prepared, and detailed specifications made out for the printer Fig 6 illustrates a printing specifications sheet, the use of which avoids any conflict with the printer It is in the form of a folder the inside of which is provided with layout ruling for the better preparation of the forms for the printer Instructions concerning type face, size of type, etc., are inserted on the layout sheet

## Speeding Up Closings and Statements

**TIME REQUIRED FOR COST REPORTS AND STATEMENTS**—At the end of the accounting period, the detailed information must be summarized and information presented in clear-cut intelligible form Monthly reports to be of value for control purposes must be submitted promptly, if possible not later than fourth or fifth day after close of period

Cost reports lose their value as they age Unless a fairly rigid schedule for these reports is established, it is generally found that each month there is some reason for delay With an established schedule for reports, these reasons for delay disappear Priority of reports should be determined and made clear to all interested parties This helps to eliminate friction Loose-leaf binders can be provided for those receiving statements but individual statements should be issued as completed No statement should be held up for the sake of presenting an executive with all of his statements as a group

Paul and Cassel (NACA Bulletin, vol 20) report that by revising the accounting methods of a certain company and with the same personnel the time for issuing monthly reports was reduced from 30 days to five days after the close of the period This is for a complete detailed operating and financial statement, however, a preliminary statement of Profit and Loss is furnished on the third day of the month

Wilson (NACA Bulletin vol 20) reports that the balance sheet is ready by the eighth or ninth of each month He states

We can produce still earlier financial statements but not economically Since our budgetary control has not yet been developed to the point where earlier statements would be of great advantage the extra pressure and cost that would be required to better our present record are probably not worth while

FORM PRINTING ORDER			
<div style="text-align: center;">Name</div>			
<div style="text-align: center;">Quantity      Number of Sheets      Total Weight</div>			
<div style="text-align: center;"> <input type="checkbox"/> 10 lb   <input type="checkbox"/> 15 lb   <input type="checkbox"/> 20 lb   <input type="checkbox"/> 25 lb   <input type="checkbox"/> 30 lb   <input type="checkbox"/> 35 lb   <input type="checkbox"/> 40 lb   <input type="checkbox"/> 45 lb   <input type="checkbox"/> 50 lb         </div>			
PAPER			
<div style="text-align: center;">             Color ———      Weight ———      Finish ———           </div>			
<div style="text-align: center;">             10 lb —      15 lb —      20 lb —      25 lb —      30 lb —      35 lb —      40 lb —      45 lb —      50 lb —           </div>			
INK			
<div style="text-align: center;">             Color ———      Weight ———      Finish ———           </div>			
BINDING			
<div style="text-align: center;">             Binding ———      Weight ———      Finish ———           </div>			
SPECIAL INSTRUCTIONS			
<div style="text-align: center;">             Price If Required      Show Proof           </div>			
DELIVERY INSTRUCTIONS			
<div style="text-align: center;">             Delivery ———      Address ———      Weight ———      Quantity ———           </div>			
<div style="text-align: center;">             Date ———      Signed ———           </div>			

fig 6 Printing Specifications Sheet

The same source also states that the main office closing procedure has been revised so that statements are issued within 24 hours after receipt of mill data. Along the same line Knuff states (NAC A Bulletin, vol 14) that it is possible to submit cost data as early as the third to the eighth day following the close of the cost period. In his own company, books are closed on about the fifth day of the month.

Early figures permit the uncovering of leaks not detected in the daily material and labor analyses. They also make possible prompt sales analyses, billing, accounts receivable statements, etc. Finally, according to Horn (N A C A Bulletin, vol 9)

The work incident to the monthly closing at head office consumes two full days after the receipt of the works reports so that allowing nine days for the completion of the work in preparation of the works reports and the preliminary work at head office during the same period with a day for the mail delivery from works to head office, all told twelve days are consumed in completion of the monthly reports.

It will also be noted that the detailed information pertaining to the works operations is available for the works managers not later than the ninth day of the following month and the statistical information obtained from the works reports is in the hands of the executives on the day following the receipt of the last works report.

Almost all of these sources state that further improvement is possible and is expected. In the presentation below, many techniques that have proved useful in practice are presented as aids in shortening the time required for the periodic reports and statements. However, it is the opinion of leading cost accountants that getting reports out on time depends perhaps more on the "will to do" than on any other one thing. They feel that even if the system is not as streamlined as it should be to get prompt reports, the "will to do" helps to streamline it.

**AIDS IN PRODUCING EARLY REPORTS**—Paul and Cassel, mentioned above summarize aids for early reports as follows (N A C A Bulletin vol 20)

- 1 Scheduling of time of accounting department for specific tasks
- 2 Proper chart of accounts
- 3 Proper general ledger controlling accounts
- 4 Definitely defined duties of members of accounting department and absolute cooperation
- 5 Establishment of standards or predetermined average costs for preliminary statement of profit and loss
- 6 Avoidance of bottleneck or the "bulge" in the work of the accounting department
- 7 Early closing of the voucher register

In the same issue Wilson mentions the following conditions as prerequisites for early reports, paying special attention to conditions of the accounts at the mills.

We have

- 1 Abandoned calendar periods to facilitate accurate and economical distribution of income and expense items
- 2 Decentralized our cost accounting procedure to avoid duplication of work
- 3 Installed a standard cost system to speed up inventory and cost of sales accounting
- 4 Arranged to close mill books of original entry promptly
- 5 Made mill accountants responsible to the controller instead of to mill managers
- 6 Installed appropriate accounting and calculating equipment
- 7 Developed a flexible and practical program of closing work
- 8 Built up a capable accounting staff

Concerning the abandonment of calendar periods, Paul and Cassel agree with Wilson on this point

To the above methods it is believed we should add the thirteen period year as an aid to cost reports. In these cases it cuts down the accountants time required in splitting the payrolls for labor and salary accruals. From that standpoint it results in cutting down the time requirements in securing the data needed for the closing.

**SHORTENING UNIT COST COMPUTATIONS**—One factor likely to delay cost statement preparation is the necessity for making many unit cost calculations. The general tendency is to carry them out for too many decimals. This involves wasted effort

- 1 In making unit cost calculations
- 2 In computing total costs

Excess digits influence the net result very little. By dropping such digits from the unit cost the number of calculations per machine operator per day can be substantially increased.

Concerning this point Kniff (N. A. C. A. Bulletin vol 14) states

A cost sheet which reflects unit costs four, five or six places beyond the decimal point is the kind of report that discourages cost interests and should be discontinued. It necessarily increases the size of the unit of production and reflect a cost in dollars and cents or two places beyond the decimal point.

Operating heads prefer brief and concise reports. Even dollars and only two places beyond the decimal point is satisfactory for exhibiting the cost of a unit in most cases.

The same principle is observed when cents are omitted from reports without reconciliation of totals, and even dollar amounts on important statements or major reports.

**STANDARDIZING REPORT PROCEDURES**—The effect of standardized procedures is to shorten the time required in the preparation of statements. Hecker (Accounting Systems) lists the following suggestions in developing a standardized procedure

- 1 A complete system of codification of accounts, operations, inventory, etc. should be developed to promote certainty and uniformity of procedure.
- 2 All daily accounting records should be promptly dispatched and schedules strictly adhered to. Where delays occur, they should be quickly detected and corrected.
- 3 As far as possible the data when first recorded should be entered on final reports thereby eliminating further copying, duplication and resulting errors.
- 4 Data needed for summarizing, such as engineering and shop factors, special payroll distributions, power factors, etc. can be developed before the last day of the month.
- 5 Many forms such as vouchers and reports can be partly filled in before the end of the month. Headings, account lists, names, comparative figures, etc. can be filled in in advance leaving only the current figures to be added when ready.
- 6 Just before the end of the month the purchasing department should go over the purchase orders which have been filled but for which invoices have not been received and prepare memorandum bills therefor. If any important detail is lacking it may be secured by



telephone from the vendor. If corrections are required later they can be made in the following month. Such minor differences in no way affect the value of the final reports.

- 7 Where branches are located at some distance the branch reports may be completed and sent in up to within a day or two of the end of the month. Additional data for the remaining days may then be sent by wire.
- 8 The accounting department must be trained to accuracy. This of course is not a responsibility of the system man but is necessary to carry out a plan of prompt reporting. The system man must develop the checks on accuracy.
- 9 Effort should be made to supply every division of the accounting department with the most efficient mechanical equipment and with efficient operators.
- 10 Employees should be trained for duties other than their own specific tasks, thereby eliminating delay from absenteeism.
- 11 Trained clerks and machine operators may be passed from one department to another as the peak loads progress through the departments.
- 12 Cooperation of all operating departments must be secured. This is not difficult once the executives become accustomed to prompt information.
- 13 Finally a schedule should be prepared for the summarizing period showing the day and hour that every task should be finished and every interdepartmental report completed. Responsibility for each movement of data should be definitely fixed.

The above points are summarized compactly by Wilson (N.A.C.A. Bulletin, vol 20)

- 1 The developments of a general ledger staff each member of which is fully trained in every aspect of closing work.
- 2 The organization of the accounting department along "group responsibility" lines.
- 3 The arrangement of the chart of accounts to make possible a compact general ledger quickly transformed into a balance sheet and income statement.
- 4 The arrangement of original records and working papers so as to permit a great deal of the closing work to be done in advance of the closing date.
- 5 The arrangement of working papers and ledgers to allow for the division of the closing work among as many accountants as are trained and available.
- 6 The elimination of such traditional bottlenecks as the trial balance book or the intra company consolidating schedules.
- 7 The rationalization of clerical and accounting procedure and personnel and the elimination of unnecessary records to facilitate early closing of books of original entry.

#### STAFF EDUCATION AND GROUP RESPONSIBILITY—

One manufacturer reports that each man in the cost department is trained to know the duties connected with the various functions of the entire department. Each is capable of summarizing the monthly transactions of any mill. This provides extreme flexibility of the staff in the matter of a division of labor. No one member is exclusively responsible for any particular task. This company stresses group responsibility as opposed to individual responsibility. In fact, the staff members are shifted from month to month to perform different functions in connection

tion with the closing process and statement preparation. If peaks develop, men can be shifted, for example, Wilson, cited above states:

The mill journal reaches us on the morning of the day we are to complete our work. Were one man to specialize in this mill and be required to do this work alone, our 24-hour schedule would be impossible. A sizable group of general ledger staff members make a simultaneous attack on this journal. All the men on the job have access to the work sheet each man posting the result of his analysis of one of the mill entries. As analyses of the mill entries approach completion a man is assigned to adding the work sheet. Long before the work is completed the bulk of its results have been transferred to the final journal voucher already in preparation. Likewise long before the voucher is completed the bulk of it has been posted to the general ledger.

A unique feature of this company's system is that the preparation of closing journal vouchers has been centralized.

The disbursement cashier, the receipts cashier, the accounts payable, accounts receivable and other minor department heads have been relieved of the monthly duty of summarizing their transactions. All journal vouchers are prepared by the general ledger staff. The decrease in the number of errors in interpreting transactions which accompanied this change has made the closing procedure smoother and more rapid.

Along similar lines Knuff (N.A.C.A. Bulletin, vol 14) reports that peak conditions can be avoided by transferring clerical help from one department to another, especially during the month end rush. His company recruits 25% of the force required at closing time from other departments.

Some overtime work is practically unavoidable during this period. In fact Wilson states that any accounting department producing early statements without some overtime is beyond any possible doubt, over-stuffed.

**CHART OF ACCOUNTS AND CONTROLLING ACCOUNTS**—The consensus of opinion is that the use of a card or chart of accounts is an effective aid in speeding up statement preparation. Knuff (N.A.C.A. Bulletin, vol 14) reports:

We issued a card of accounts which provided for strict uniformity in all of our manufacturing accounting. A code number was provided for each account to permit the use of mechanical tabulating. By this method we eliminate descriptive accounts on our recapitulations of labor, stores and inventory accounts as the code numbers are used when tabulating by hand or machine.

Time savings can be effected through the use of charts of accounts by

- 1 Limiting the number of major chart classifications to the number of captions on the company's balance sheet and income statement.
- 2 Arranging the accounts in the order in which they appear on the company's statements.

In this way, the general ledger because of its small size is quickly posted and balanced and results in an early balance sheet and profit and loss statement. In effect this makes the general ledger a book containing mainly controlling accounts. In one company investigated by Paul and Cassel (N.A.C.A. Bulletin, vol 20) the following controls were established:

- 1 Factory Ledger
- 2 Delivery Expense
- 3 Selling Expense
- 4 Administrative Expense

These controls made easier the preparation of the preliminary and final profit and loss statements because

- 1 Trial balances of the controls may be postponed for the final statement
- 2 The accounting work can be distributed to different members of the accounting department at the time of the period loads for that department
- 3 Accounting and tabulating machines can be more readily adapted to a system having proper ledger controlling accounts

**TRIAL BALANCE**—Some companies use the monthly trial balance as a step in quick statement preparation. Thus one company using 26 controlling accounts lists them on a trial balance sheet following their order in the general ledger which in turn follows the order of their appearance on the statements. The accounts are segregated in groups, each group being designated by a key number. By providing adjustment columns the total of each group represents an item on either the balance sheet or profit and loss statement.

However, Wilson, mentioned above, disapproves of the conventional trial balance book. He states:

A good many companies have designed the trial balance to serve an additional function making it the means of grouping the various accounts in the general ledger which must appear as a single item on the balance sheet or income statement.

The grouping process is of course unnecessary in a general ledger whose accounts coincide with the statement captions. Also the accounts being few, posting can be made directly from the general ledger to the major statements omitting the trial balance. The correctness of the general ledger posting is automatically proved when the income statement results in a net profit figure which checks with the balance sheet.

**MECHANICAL EQUIPMENT**—Success in securing early statements is usually due to some kinds of mechanical equipment. Duplicating equipment, tabulating equipment, mechanical calculators, etc. are quite widely used. It is the duty of the cost accountant to determine what accounting and tabulating machines can cut costs in the department and facilitate the handling of the great mass of details in producing early reports. Trained operators must, of course, be provided. Some companies investigated rely on tabulating equipment to cut the time required for statement preparation. Others prefer hand and machine sorting, as well as duplicating equipment (see later discussion). Accounting and calculating equipment and, in general, the rationalization of clerical and accounting procedures are important factors in promoting early closings.

**USE OF TIME SCHEDULES**—In order to make certain that reports are received at specified times, a schedule is laid out showing the exact time when such reports are due. Failure of one section to meet this date line may entail delays in other sections. A large steel company has the following index to its **monthly closing schedule**

## INDEX

## MASTER SCHEDULE

Page

Third Last Day  
 Second Last Day  
 Last Day  
 First Day  
 Second Day  
 Third Day  
 Fourth Day  
 Fifth Day

## DEPARTMENTAL SCHEDULES

General Bookkeeping Department  
 Billing Department  
 Accounts Payable Department  
 Treasury Department  
 Tabulating Department  
 Plant Payroll Department  
 Manufacturing Cost Department  
 Cost Production Department  
 Distribution Department  
 Stores and Stationery Department  
 Raw Materials Department  
 Sheet Mill Production Department  
 Steel Mill Production and Other Miscellaneous Departments

The following scheduled items are selected from the manufacturing cost department schedule for the third day of the month

SCHEDULE OF REPORTS  
 MANUFACTURING COST DEPARTMENT  
 Third Day of Month

- 8 00 AM - Manufacturing cost department will receive from the distribution department the inventory charges for the steel division
- 9 00 AM - Manufacturing cost department will receive from the cost production department the steel division 32 and 18 mill sheets
- 10 30 AM - Manufacturing cost department will receive from the distribution department the steel division cost exhibits
- 11 30 AM - Manufacturing cost department will furnish the billing department with the final billing
- 12 00 M - Manufacturing cost department will receive from the cost production department the steel 34 and 24 mill metal sheets
- 1 00 PM - Manufacturing cost department will receive from the general bookkeeping department royalty voucher no 2
- 3 00 PM - Manufacturing cost department will furnish the general bookkeeping department with all miscellaneous vouchers
- 4 00 PM - Manufacturing cost department will receive from the distribution department the shop factor totals
- 5 00 PM - Manufacturing cost department will receive from the cost production department the steel division 20 mill metal sheets
- 7 00 PM - Manufacturing cost department will receive from the cost production department the steel division 18 and 12 mill metal sheets
- 8 00 PM - Manufacturing cost department will receive from the cost production department the steel division 9 mill metal sheets
- 9 00 PM - Manufacturing cost department will receive from the cost production department the steel division 8 mill metal sheets

The closing cost procedure of another steel company as reported by Knuff is as follows (N A C A Bulletin vol 14)

- 1 Closing of the payroll record and labor distribution the latter usually completed by noon of second day
- 2 Closing of stores records and the monthly distribution of stores material and supplies
- 3 Closing of raw materials inventory records and the distribution of material other than stores
- 4 Closing of production records and the verification of product inventories
- 5 Summarization and classification of all product shipments made during the month
- 6 Distribution and redistribution of service departments auxiliary producing departments etc to producing departments
- 7 Determining the cost of sales value of all products shipped during the calendar month
- 8 Compiling the gross profit and loss statement
- 9 Closing journal entries to the general ledgers of the corporation (All of this accomplished by noon of the fifth working day)
- 10 Compiling the general financial statements

To accomplish all this, use is made of daily accounting summaries, which eliminate peak conditions during the month and planned schedules of work connected with the closing program. Strict adherence to these schedules is required. Knuff states

The schedule for monthly closing, is arranged departmentally and the specific day and hour of the time the report is to be furnished is indicated. For example

'At 2 30 P.M. on the second day of the month the distribution section will furnish the cost department with cost sheets which will include the labor and stores distribution properly balanced with the controls'

The responsibility for data received by the distribution department to carry out the above schedule rests with them and no alibis are accepted.

This same rule applies to all departments scheduled and when information is received from other than accounting departments the same rule applies.

A detailed procedure followed by a sulphur mining company is furnished by Adamson (N A C A Bulletin, vol 15)

Immediately upon punching the final card for the last journal entry and cash voucher all of the tabulating cards are easily hand sorted into journal entry order from which formation a statement of debits and credits by journal entries is tabulated. For this statement the cash voucher cards are removed and a dummy card of their aggregate amount is substituted. This prevents a listing of the cash vouchers which is taken care of by a separate statement reconciled with the cash book. A convenient list of journal entries also serves as a means of balancing against the manual control. Its tabulation requires about 45 minutes.

All of the cards including those for cash vouchers are then sorted according to general ledger account cost account and work order. This sorting requires 1 hour and 15 minutes. Upon completion a statement of debits and credits by general ledger accounts is tabulated in 45 minutes to provide a source of balance for the cost statement.

The tabulation of the cost statement takes 2 hours but as promptly as one schedule is off the machine it is passed to the employee with the proper skeleton form on which he has already posted the budget figures.

and to which he now transcribes the figures from the tabulated page. His completed work sheet is then passed to the comptometer operator for checking.

Two stenographers type all the stencils in a little over half a day using elite type machines. On the 8½ x 11 page there is accommodated the work order number (under its cost account) a brief definition of it and the five columns of figures viz Labor Material Expense Total and Budget.

After the stencil has been typed and the heading work order number and definitions verified the figures are again checked on the comptometer. The mimeograph department keeps an operator on our work until all schedules have been run.

All operations are going on simultaneously. The tabulated pages are coming off the tabulating machine, four employees are copying from these pages to the skeleton forms, the comptometer operator is checking work sheets and stencils, the two stenographers are pounding out more stencils, a bell comes for a couple of employees who call back a few stencils against work sheets, the mimeograph is turning out 20 printed copies of each stencil. The bookkeeper is rapidly posting the general ledgers so that he can obtain the figures for the summary from the general ledger accounts with which the totals of the various schedules balance. We have a completed cost statement by the third day of the succeeding month.

On a separate sheet for each work order number we typed the descriptions and costs of materials charged out on the warehouse requisitions. This is done by various stenographers in the office during their spare hours throughout the month so that a detail of material distribution for each work order is furnished to the department simultaneously with the cost statement. The total cost on these detailed sheets, after the overhead percentage is added, will correspond with the amount of material column of the cost statement for each particular work order.

The entire accounting report covers 40 to 50 mimeographed pages 8½ x 11 in size.

**PREPARATIONS FOR CLOSING**—To be effective, the procedure in closing books and preparing statements must be standardized. To this end all the aids mentioned above must be put into effect. In addition, a good deal of work can be done in advance. This involves advance preparation of recurring journal vouchers, use of skeleton forms, etc. In one case that of a steel company data for service expense distributions are prepared in advance and furnished on the first day of the month. These cover engineering and shop factors, special payroll distributions, steam water, electric power and air factors. A supply of skeleton reports, vouchers, statements, etc. is also kept on hand.

All records which can be closed before the end of the period must be summarized before the rush begins, this is true of both main office and cost records. Accruals for monthly statement purposes cover only the major profit and loss items.

**Fixed Charges**—Journal vouchers for fixed charges covering depreciation, taxes, insurance, etc., are prepared and entered before the close of the period, in fact, standard closing journal entries in skeleton form may be used.

**Planning the Closing Program**—The planning and execution of the closing program involves all the points mentioned above designed to eliminate bottlenecks. These points are summarized by Wilson (N A C A Bulletin, vol 20).

1 Review the situation of the various subdepartments well in advance, and shift additional staff to those behind in their work

2 Have the necessary forms planned in advance Working papers consolidating schedules and financial statements are much alike from month to month Each can be planned and a supply adequate for a year or more prepared on a duplicating machine Thus accountants will merely have to fill in the current figures

3 Have comparative data such as budget figures or prior month or prior year figures filled in before the closing date arrives

4 Have as much of the closing work as possible done before the end of the month This includes preparation and posting of some journal vouchers and the larger part of the analyses of such books (if manually analyzed) as purchase register cash receipts etc

5 Defer as much current work of the new month as possible until after statements have been completed

6 Split the general ledger and the subsidiary ledger into small sections and divide among the available accountants for the necessary mathematics

7 Assume that mathematical work is correct until the reverse is proved As with the general ledger so with the subsidiary ledger post directly to the subsidiary financial statements analyzing inventories or expenses When the statements are finished check with the controls Nine out of ten will balance and a good deal of tedious checking and preparation of trial balances will have been avoided

8 Ignore minor differences in intercompany or interdivisional accounts Treat them as deferred items and make investigations and adjustments in the following month

9 When as in our case several companies are involved since consolidating schedules must immediately precede the preparation of the statements they necessarily represent a bottleneck Cut these schedules into small parts, e.g. one for assets one for liabilities, one for income from operations and one for net profit and distribute them among the staff, thus reducing the time required

10 With sound preparation a well trained staff and careful avoidance of bottlenecks the balance sheet the profit and loss statement and the supporting schedules for the various classes of expense for inventory etc are completed on the evening of the day that final data are received from the mills

**Preprinted Journal Vouchers**—Use of preprinted vouchers, mentioned above, is almost universal One manufacturer uses a standard set of nineteen printed journal vouchers, showing all information except the amounts the latter are filled in manually The same manufacturer employs standard working papers prepared a week in advance of closing Also all possible entries are made out at the main office prior to the receipt of the works report and posted Upon receipt of the latter, only the works operations need be balanced and journalized The work may be further simplified by reference to a suitable work sheet which is so arranged as to yield the entries for all twelve months by use of appropriate columns

Wilson describes an extension of this method to regularly accrued expenses (NACA Bulletin vol 20) A columnar arrangement is used to note the monthly amounts to be written off The journal voucher is then readily prepared in advance, by summarizing items appearing in the current month's column The same company employs a journal in the form of 27 numbered vouchers, the same numbered voucher covering the same summary each month Thus voucher No 2 covers depreciation, No 6 main office purchases, and No 27 (Fig 7) covers the

SIDNEY BLANK & SONS JOURNAL VOUCHER OFFICE OF THE STATE (and no. 1)		SUBJECT OF ENTRY Summary of Transactions of Mill B		NO. TH. 10 NO. 27 19__ PAGE 1 OF 1				
A C C O U N T S		SUBSIDIARY ACCOUNTS		GENERAL LEDGER ACCOUNTS				
		SYMBOL	F	AMOUNT	SYMBOL	DEBIT	F	CREDIT
Cash					0100			00 000
Mill Payroll Accounts	0105	✓	00 000					
Impressed Funds	0108	✓	0 000					
Miscellaneous Accounts Receivable					0600	0 000	✓	
Mill Receivable	0601	✓	000					
Mill Claims	060	✓	0 000					
Waterproofing Insurance	0605	✓	000					
Raw Materials					1100	00 000	✓	
Yarns	1101	✓	00 000					
Cyos	1102	✓	00 000					
Expense Supplies	1105	✓	0 000					
Work in Process					1300	00 000	✓	
Finished Goods					1600		✓	000 000
Inventory Reserve					1700		✓	00 000
Crucialproofin Royalty	1701	✓	0 000					
Rubberizing Royalty	1702	✓	0 000					
Land Buildings Equipment					2300	000 000	✓	
Machinery & Equipment	308	✓	000 000					
Automotive Equipment	2,09	✓	0 000					
Accounts Payable					3100		✓	000 000
Accounts Payable Trade	3101	✓	000 000					
Unaudited Cills	3105	✓	0 000					
Accrued Taxes					3200		✓	00 000
Property Tax s	3,05	✓	00 000					
U S Old Age Benefit Tax s	3210	✓	0 000					
Unemployment Insurance Taxes	3211	✓	0 000					
Cost of Sales at Standard					7100	000 000	✓	
Mill Overhead Absorbed					8100	0 000	✓	
Excess Defective Manufacturing Expense					8700		✓	0 000
Mill Profit and Loss					8400	0 000	✓	
Purchase Variance	8401	✓	0 000					
Use Variance	8401	✓	000					
Labor Variance	8407	✓	000					
Wending Variance	8415	✓	000					
Selling and Delivery Expense					900	0 000	✓	
Shipping Supplies	9163	✓	000					
Exhibition Expense	917	✓	000					
Sample Expense	9284	✓	000					
TOTALS						0 000 000		0 000 000
PREPARED	AUDITED	POSTED		POSTED		APPROVED		
BY J M DATE 11/7	BY J B DATE 11/1	BY B E DATE 11/7		BY B G DATE 11/7		BY ACH DATE 11/7		

FIG 1 Mill Summary Journal Voucher



transactions of a branch mill. In effect these vouchers constitute a loose leaf journal. Each voucher is thus an independent unit in its preparation, auditing, approval and posting.

**WORKING PAPERS**—Preparation of journal vouchers must rest on adequate working papers to support the entries. Practice varies in this respect, but in the case of the above-mentioned company each regular journal voucher has a separate file of working papers which accumulate the information required for the voucher and support the latter in case of investigation or audit. Each file is numbered to correspond to the journal voucher number and covers an entire year. The form of the vouchers differs of course depending on the activity covered.

## Cost System Installation

**NATURE OF PROBLEM**—In the absence of a separate methods department it often becomes the duty of the cost department to initiate changes in the cost system. It may be that an entirely new system is required or a re-designing of parts of the existing system. A certain amount of tinkering always goes on, and the cost department is usually called upon to take an active part in installing or revising the cost system.

The design and installation of a cost system are only part of a much larger job of organization, experimentation, and standardization of the entire plant. A cost system cannot operate satisfactorily in a plant poorly organized. The essential problem is to coordinate the production factors of material, labor, machines and tools in order to secure a continuous flow of product in proper quantity and of proper quality. Hence a good cost system should be designed to tie in with a system of production control. Opinion, however, differs as to who is to design and install the system, whether the job is to be done by an outsider or is to be developed from within. The outside accountant or industrial engineer possesses objectivity, special training in systems installation work, and possibly experience in installations for plants doing similar work. The factory man, however, has greater experience with, and more detailed knowledge of, the given plant, its processes, and its special problems.

**STEPS IN SYSTEM INSTALLATION**—Opinion differs as to the order of steps to be taken in systematizing a plant. The following summary statement of the problems involved in the development of scientific management in a plant is taken from Hathaway (Industrial Management vol 60)

- 1 Development of an organization plan for departments and subdivisions defining authority, nature, scope and limitations of activities and relations and responsibilities of each department.
- 2 Development of a layout plan of departments and equipment to provide for the rearrangement when necessary, and to include provision for expansion and new departments in accordance with the organization plan.
- 3 Collection and codification of data relating to product.
- 4 Collection and codification of data relating to machinery and other equipment.

- 5 Standardization of machines and development of a maintenance system
- 6 Standardization of tools and development of a toolroom system
- 7 Development of a stores system
- 8 Development of an order system
- 9 Development of a timekeeping system to serve accounting purposes
- 10 Development of a routing system including complete planning in advance of work to be done in turning out product
- 11 Development of methods to follow up and control work in process
- 12 Development of time study, development and standardization of operations and operating methods and a pay system based thereon
- 13 Development of a cost accounting system

It is to be noted that a **cost accounting system** is installed only after all other factors have been properly systematized and standardized. However, the development of the above factory controls should take into account the kind of cost system to be introduced eventually.

**SURVEY OF COST ACCOUNTING SYSTEM**—The cost accounting system, to operate properly, must be an integral part of the general accounting system. In some companies the cost work is handled by the same persons as the general accounts although in larger companies the cost department is a separate unit. To insure proper coordination between the cost system and accounting department the existing set up should be closely examined both for personnel and for records. The following steps adapted from Heeler (*Accounting Systems*) should be taken in surveying the present accounting system:

- 1 Obtain a list of books in use
- 2 Secure the classification of accounts and note the approximate number of accounts in each of the subsidiary ledgers and the activity of these ledgers
- 3 Get samples of all forms in use
- 4 Investigate the cost system in use, the nature of costs kept, cost statements prepared and their relation to the general books, note how costs are collected, burden distributed, etc.
- 5 Examine financial statements now prepared
- 6 Note the division of responsibility in office
- 7 Note the office appliances of an accounting nature
- 8 Ascertain who prepares the payroll, how paid, how distributions are made and how time records are handled
- 9 Examine the procedure for handling production orders, planning, scheduling, routing, reporting, etc.

To carry out the work connected with the survey and the design of the new system, carefully prepared **working papers** are required. Fig. 8, taken from Greer and Mautner (*Systems Installation in Accounting*), shows in diagrammatic form the method of preparing the working papers.

**MANUAL OF ACCOUNTING PROCEDURE**—When forms have been designed and the new system is ready to operate, a manual of accounting procedures is written giving the instructions for the execution of the various procedures and mechanics provided in the system. Many concerns use a manual or guide book which outlines the system in detail, complete with chart of accounts, lines of authority, priority in reports, etc. Such a book is of extreme value to an accounting department. It is an education for new employees, especially since

it may eliminate misunderstandings in the department. A manual is best made up in loose leaf form because from time to time changes are made in the system to fit changes in the manufacturing process and in the data required for executive reports. A copy should be given to all of the cost department personnel.

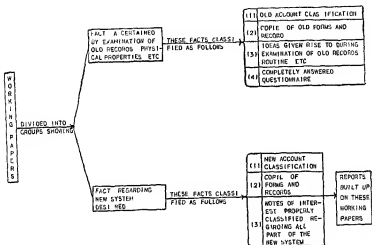


Fig 8 Chart Showing the Method of Preparing Working Papers

**Content of Accounting Manual**—Manuals of procedure may be classified as follows

- 1 General handbook for employees
- 2 Manuals of functional or departmental procedure
- 3 Detailed performance and instructions

The manual must set forth all necessary instructions pertaining to the accounting and statistical procedure as designed by the system man. According to Thompson (Accounting Systems) the manual should cover instructions on the following points

- 1 List of records and forms
- 2 Use and routing of forms
- 3 Chart of ledger accounts
- 4 Explanation of each account
- 5 Monthly statements and reports

A somewhat more complete statement covering the contents of the accounting manual is contained in Hockett

- 1 Purpose and use of manual
- 2 Method of initiating and approving changes
- 3 Organization of accounting department
- 4 Classification and manual of accounts

- 5 Detailed instructions for individual procedures
- 6 Methods of analyses of operation items
- 7 Summarizing and closing schedules and procedure
- 8 Schedules or reports indicating departments responsible for their preparation to whom given and when
- 9 Regulations regarding the establishment and upkeep of a file of all forms and records in use
- 10 Miscellaneous instructions for example filing classifications material classifications standard form letters sections of interest tables conversion tables, tables of equivalents

The following paragraphs illustrate instructions concerning some of the ledger accounts taken from a manual for a large industrial organization as quoted by Geier and Mautner (*Systems Installation in Accounting*)

**Machinery**—This account represents the cost of all machines required. Also charge to this account any improvements that represent an increased value to the original cost of this asset.

Proper provision for depreciation of this account should be made monthly (see account Provision for Depreciation of Machinery)

**Cost of Completed Contracts**—This account represents the cost of completed contracts as transferred from the cost record ledger, monthly entry for which is made in the general journal

**COST SYSTEM CHANGE OVER**—Once the plan of cost records has been devised and the necessary record forms prepared there remains the problem of putting the system to work. The necessity for having complete understanding of and agreement with the system, before it is installed, by everyone who is to operate or be served by it, is of great importance. The omission of this step has blocked the effectiveness of many otherwise excellent cost systems.

Individual circumstances condition the method of making the actual installation. If the company is a small one, the cost system can probably be installed in one step. In some companies requiring very elaborate systems, the installation is, of necessity, made piecemeal. In any event the inconvenience of change-over from the old to the new system must be reduced to a minimum so as to interfere as little as possible with established routines. Nevertheless, a definite line of demarcation between the old and new systems is desirable. Where the attempt is made to introduce the new system piecemeal, the procedure is apt to be long drawn out. The better practice in the installation of a new system is to have all forms, manuals and instructions ready to put the new system into operation at a definite date. At the set date the old system is cut off, records of work in process and other inventories are transferred to the new system and operations begin. The change to the new system, whether made all at once or in sections, should follow very definite, clean cut steps. Journal entries should be made recording the transfer of values from the old to the new accounts.

As a compromise between the two methods outlined it may be desirable to operate both the old and new systems together for a brief time in order to reduce the inevitable confusion of the period of transition. The sudden cutting off of information to which people have become accustomed and the substitution of different information even though that different information has been thoroughly explained and is more

useful, is not infrequently too great a shock for some of the people the new information is intended to serve. Wherever practicable, it is desirable to get into the routine of using the new information before old reports are completely discontinued.

**Timing of Installation**—The timing of installations of new cost and accounting systems is important. If the reports under the new system

**Taking Inventory**—On the date the cost system is to be installed, an inventory should be taken of all raw material. During the taking of this inventory there should be a cut-off on all receipts and issues. If stores issues or receipts are unavoidable, they should be marked "before inventory" or "after inventory" as the case may be. When the inventory is completed, the balances of the various items on hand can be posted to their respective raw material cards. Individual items should be priced and extended to determine the actual value of materials on hand. The account in the general ledger for raw materials should be adjusted to reflect this new balance.

In making the transition from the old to the new, it is possible that accurate inventories are not available. In this event estimated inventories must suffice and adjustments be made at a subsequent date.

**Control of Work in Process**—If the company maintains a separate job number for each order, job order sheets must be set up. An inventory of goods in process is taken. The total value, as nearly as can be determined, is charged to Work in Process in the general ledger. Individual job or cost sheets are charged with the costs of individual jobs in process. The total of these individual sheets should agree with the total of the general ledger Work in Process account. As current charges for labor and material develop, they are charged to these cost sheets and to the control account. Overhead expense is charged to jobs on the basis of a predetermined percentage. As jobs are completed, their cost sheets are totaled and transferred to the finished goods ledger, a proper transferring entry having been made in the general ledger.

If a process cost system is contemplated, it is necessary to provide for suitable process accounts and interdepartmental transfers. If a standard cost system is to be introduced the method of charging and crediting Work in Process must be decided, and detailed procedures worked out.

**Control of Finished Goods**—Control of finished goods is next established. Finished goods on hand are inventoried and valued as accurately

as possible. The total is set up in the general ledger as finished goods. Stock cards are prepared according to finished goods classifications and opening balances are posted to the cards. As work in process is completed it is transferred to the finished goods ledger.

**REVISION OF AN OLD SYSTEM**—Frequently a concern finds its present cost accounting facilities satisfactory except for perhaps one or two phases. A system of standard costs may be desired to supplement what is already an excellent system of actual cost. In such cases a completely new system need not be installed.

If the revision is a minor one, it can be made without a general survey of the company's operations. However, if the revision is to be broad in scope, it might be well to attack the problem as though a completely new installation were to be made. When the proposed system is completely designed, the existing facilities which are satisfactory can be used and the old discarded.

**SUPERVISION AFTER INSTALLATION**—Many systems are still unsatisfactory because of a lack of supervision by the system man when an installation has been effected. When a new product is brought out, production "bugs" invariably develop; these must be ironed out before a smooth flow of production of the desired volume is secured. In the same way unexpected difficulties develop in the most carefully designed and installed cost systems. After the system has been in operation some changes may be found advisable:

- 1 Change of standards
- 2 Changes in overhead rates
- 3 Number and content of cost reports may be increased or decreased
- 4 Procedure in handling forms may have to be changed

At end of the first annual period the cost accountant must supervise the first closing of the books and prepare the required closing journal vouchers. With the books closed the annual statements are made up together with a statement on the results obtained from the first year's operations.

If outside accountant is retained to make the annual audit an opportunity is provided to make changes and improvements in the system from time to time. This is necessary because the cost system is something organic and must grow and adapt itself to changing conditions. Continuous revision is essential for maximum results.

## SECTION 5

### ORGANIZING THE COST RECORDS

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## SECTION 5

### ORGANIZING THE COST RECORDS

#### Cost Definitions

**COST DEFINED**—When the word "cost" is used it is usually preceded or followed by other words which are helpful to an understanding of the term. Material costs, labor costs, conversion costs, cost accounting, cost systems, cost statements, cost departments are illustrative of the manner in which the word is used.

Cost may be said to refer to outlays or expenditures made to acquire goods or services. These expenditures should be classified or grouped so as best to serve the needs of those who intend to use or analyze them. Thus groupings may be by functions such as manufacturing or distributive activities or by nature of expenditures such as materials, labor, rent or may be combined in order to secure costs by manufacturing processes or by units of output. Van Sickle (*Cost Accounting*) states:

The word cost in an accounting sense cannot be defined unconditionally. Cost becomes an individual formula in each business enterprise. Cost to some means the actual money outlay past and present for the cost of production. To others cost includes not only the cost of production but in addition the marketing and administrative expenses combined to represent an overall or commercial cost. The varied nature of production and the size of the business have something to do with its formulation.

**COST ACCOUNTING**—On the same theory that engineering is divided into various branches or classifications, accounting has been likewise divided. Cost accounting applies the principles of accounting in such a manner that the management is always assured of a detailed recording and analysis of expenditures incurred in connection with the operation of any business or division of the business, such as manufacturing, selling, administration or the production of any article so that it is able to measure performance and control activities.

Cost accounting in a manufacturing sense, is that branch or division of accounting designed to deal essentially with production factors. According to Van Sickle (*Cost Accounting*),

Cost accounting is the science of recording and presenting business transactions pertaining to the production of goods and services whereby these records become a method of measurement and a means of control. Cost accounting embodies the analysis and synthesis of cost transactions in such a manner that it is possible to disclose the total production cost of a com-

modify a job or a service in addition to their cost element make up in terms of material, labor, and factory overhead costs. Cost accounting also includes an analysis and synthesis of the total cost of production in terms of department cost center and manual and machine operation costs. The compilation of the production costs provides a basis for determining the cost of goods sold which is also another phase of cost accounting.

Cost accounting is made up of

1. Mechanics of cost keeping.
2. Analysis of costs to measure managerial efficiency.
3. Installation and supervision of cost systems.

Hence, according to Neuner (Cost Accounting)

Cost accounting is a phase of general accounting procedure through which details of the costs of material, labor and expenses necessary to produce and sell an article are recorded, summarized, analyzed and interpreted.

The term "cost keeping" refers to routines followed in recording and classifying expenditures. It is primarily clerical and relates to the application of bookkeeping procedures to the classification and recording of details of expenditures so as to permit the accumulation and analysis of cost information.

**COST ACCOUNTS**—Common usage limits the term "cost accounts" to groups of accounts in which are assembled expenditures relating to manufacturing operations to selling activities or to administrative procedure in such a way that the cost of these activities is revealed in terms of some unit that has been selected as a yardstick. In a still narrower sense cost accounts refer only to those accounts in which are recorded outlays pertaining to manufacturing operations that is, to costs connected with the internal movements of a product between the raw material and finished goods stage. On the other hand financial accounts are contrasted with cost accounts are more concerned with financial changes arising as a result of transactions involving external forces.

**COST SYSTEMS**—A cost system may be defined as a systematic record of all financial transactions expressed in their relation to the functional factors of production, distribution and administration properly interpreted to disclose the cost of performing a given function. The records involved consist of those original documents, journals, ledgers, operating statements, and account classifications which are required if adequate details of plant, sales and administrative expenditures are to be submitted to responsible executives. The nature of the product being manufactured, processes of manufacturing, methods of sales distribution, and forms of reports to be submitted to management are important factors to be considered in the design of a cost system.

**Types of Cost Systems**—Ordinarily cost systems are classified as either job order, process estimated, or standard costs. Each of these is thought of as an independent system. A more orderly classification, however, is gradually being recognized. Costs may be segregated on the basis of time, i.e. whether the costs in question are historical or actual costs or whether they represent predetermined costs. Within these two divisions costs are then subdivided on the basis of the type

of production engaged in. On this double basis the following classification results:

- 1 Actual or historical costs
  - a Job order costs
  - b Process costs
- 2 Predetermined costs
  - a Estimated costs
    - 1 Job order
    - 2 Process
  - b Standard costs
    - 1 Job order
    - 2 Process

Frequently, variations or combinations of job and process costs are found in industry, particularly where a company handles different classes of work in the same or different departments. Important variations from pure types are:

- 1 Operation costs (see Section 9)
- 2 Class costs (see Section 9)
- 3 Assembly order costs (see Section 8)

**Extent of Use of Different Systems**—The classification outlined above has not received universal recognition as is evidenced by the tabulation below in which job, process and standard costs are treated as independent systems. In the course of a study made by the Research and Technical Department of the National Association of Cost Accountants 325 companies, mostly large or medium sized and representing a wide variety of industries reported on methods or types of cost accounting used (N. A. C. A. Bulletin, vol 21). A summary of the answers follows:

#### METHOD OF COST ACCOUNTING USED

	Companies
Job costs	66
Process costs	67
Ideal or current standard costs	103
Basic or measure standard costs	21
Various combinations of job process and standard costs	44
Unclassified	18
No answer to this question	6
	<u>325</u>

Note that 44 companies reported using various combinations. There is no question that job order costs can be made a part of a standard cost system.

**HISTORICAL COSTS**—A cost system which records and summarizes costs as they occur, and which determines costs only after manufacturing operations have been performed or services rendered, is said to be an actual or historical cost system. Historical costs are costs actually incurred and therefore can be computed only at the end of a cost period. Because of the amount of services required and expense involved, much criticism in recent years has been advanced against cost accounting systems operating on an actual cost basis. It has been main-

tuned and rightly so in many cases that unnecessary effort is put forth to determine the actual cost of similar products or operations month after month.

**Limitations and Advantages**—The limitations of cost systems employing actual or historical costs may be summarized as follows:

- 1 By the time statements are prepared the information revealed by them comes too late to be of much use in correcting evils resulting in excessive costs.
- 2 There is no measuring stick against which to compare actual costs. The management knows only that the costs are greater or smaller than last time but does not know why.
- 3 If there is a measuring stick in the form of a prior estimate of costs it is difficult to determine whether an error was made in estimating or whether the figures are the result of inefficiencies in operation.
- 4 Actual costs are of only limited use in fixing selling prices because the overhead is high in periods of low production and vice versa (see Section 19).
- 5 An actual cost is not a typical cost but may more accurately be described as an accidental cost.

**Advantages** of the historical type of cost systems arise from the fact that historical costs represent costs actually incurred on specific work or for a given period. Such costs are of value especially in cost plus work, particularly in negotiated government contracts on the basis of cost plus a fixed fee or a stated percentage.

**PREDETERMINED COSTS**—Predetermined costs are costs estimated in advance of production on the basis of specified future conditions. They are found in estimated as well as standard cost systems. In either case management is primarily interested in what the costs should be, and only secondarily in what they actually are. In fact **actual costs** are accumulated merely for comparison with predetermined costs in order to secure **variances** as a measure of departure from predetermined figures.

**Estimated Costs**—Estimated costs represent more a method of cost approximation than a system of costing. Estimates are compared with actual costs and errors in estimates are corrected. Such costs are less accurate than costs obtained by means of a historical type cost system, but this disadvantage is offset by savings arising through the elimination of much clerical detail. The estimate is prepared in advance of production. This type of costing often called **specification costs** may supplement financial accounting, procedures of concerns which lack adequate cost systems or which have incomplete cost systems. It is used by building operators, road contractors and manufacturing plants, such as clothing concerns which sell their output on a seasonal basis, in advance of manufacture.

**Standard Costs**—In this type of cost predetermination scientific estimates are made of the quantity and prices of material, of labor, and of overhead to be used in each process or operation or for each article of product. A complete cost system is kept in which established standards are recorded. Analyses of **variations from standard** are made as they occur and necessary steps taken to eliminate unfavorable variations (See Sections 2-7).

## Objectives of Cost Systems

**LIMITATIONS OF FINANCIAL ACCOUNTING**—Some of the defects or limitations of financial accounting are listed by Blocker (Cost Accounting) as follows:

1 The classification of accounts does not give data regarding costs by departments processes products and units in the manufacturing division by units of product lines and sales territories in the selling or distribution division and by departments services and functions in the administrative division.

2 Frequently materials and supplies are not properly controlled and misappropriation deterioration obsolescence and losses from scrap and defective parts result.

3 Wages and labor are not recorded by jobs processes departments or services and are not interpreted in the light of cost factors. No company wide system of incentives is used to compensate laborers, clerks, salesmen and executives for above standard performance.

4 Expenses are not classified as to direct and indirect items and are not assigned to the product at each stage of production to show the controllable and uncontrollable items in overhead expenses.

5 There is no well developed system of standards to appraise the efficiency of the organization in the use of materials incurrence of labor and overhead expense by comparing the work of laborers clerks salesmen and executives with what should have been accomplished in producing and selling a given number of products in an allotted period of time.

6 The accounting is historical since the data are summarized at the end of the accounting period. There is no day to day cost information obtainable and there are no budgetary elements permitting the computation of predetermined costs.

7 Costs are not available as an aid in determining prices of products services production orders or lines of products.

8 There is no complete analysis of losses due to idle plant and equipment showing cost variations between active and inactive periods and seasonal conditions in the industry.

9 In contemplated plans for expansion or contraction of plant and equipment it is impossible to appraise and compare properly the profitability of alternative methods, high cost of maintenance and differences in efficiency between types of equipment.

10 Adequate information is not available for reports to outside agencies such as banks credit associations federal state and local governments insurance companies and trade associations. It is impossible to prepare detailed reports for management exhibiting complete cost data regarding operation of the enterprise for purposes of comparing such data with other periods of operation and with other concerns in the industry.

**MANUFACTURING PROCESSES AND COST DETERMINATION**—The classification, recording, and assembling of outlays in such a manner as will enable management to know the costs of each process or each unit of product represent a part of the functions of cost accounting. Even so simple a product as a knife goes through many processes before it may be offered for sale. Dolliver (N.A.C.A. Bulletin vol. 20) states:

One piece knives are forged either hot or cold from a round bar of metal.

The forge blank is then heat treated or tempered and cut out to shape in a power press. From that point on the various types go through many various processes depending on the final finish that the completed product

is to have. A typical line would move through the following processes: cutting out grind blade and finish handles rims and bolsters tumbling, plating mirror finishing, final handle finish, final final blade finish, plate cut silver from metal color blade finish handle inspect and pack. This particular treatment may apply to only one item in the line, whereas another line out of the same plant would follow an entirely different routine of manufacture. We may make 25 dozen of one item in a year and 100,000 dozen of another item with process time varying from four days to four months for various constructions. The total dollar and cents volume and the intensive competition in the manufacturing of cutlery make it necessary to keep expenditure for controlling production and costs at a bare minimum yet we must have a positive control of these factors.

Hence costs must be **classified** and related to the product which is being manufactured. Furthermore costs must be allocated to processes of manufacture if a knowledge of the cost of each process is deemed essential. Reports of costs as classified and allocated must be submitted in appropriate form to management if the latter desires to have a knowledge of costs in relation to output.

The chart of **manufacturing processes** (Fig. 1) from Sanders (Cost Accounting for Control) illustrates the relationship of costs and manufacturing operations. Costs are assembled for materials used, labor applied, and manufacturing expenses incurred for each process indicated in the chart. These costs are accumulated as raw material passing from one process to another finally becomes a finished product available for sale.

**PURPOSES AND VALUE OF COST ACCOUNTING**—Cost figures developed upon a sound basis are certain to have a value that may be measured in dollars and cents. Many executives have stated that information flowing to them from the cost department has been the most important tool for effecting efficient operation. Cost accounting fulfills the following objectives:

- 1 To control expenditures
- 2 To price products
- 3 To provide basis for operating policy

**To Control Expenditures**—The average manufacturing company with changes in product, method of manufacture and personnel requires a definite method of control of all expenses. Cost accounting provides data used as a basis of study. From a study of production costs foremen learn how to correct errors and improve methods. A study of cost data reveals to a factory superintendent definite information to be used for cost reduction. It is a constant aim of modern manufacturing companies to reduce costs through more efficient methods, to substitute materials to eliminate so-called fixed expenses and to affect many other factors contributing to the cost total. Cost figures furnish information for savings by:

- 1 Elimination of waste
- 2 Planning labor on an economical operating plan
- 3 Definite control of expenses throughout the plant
- 4 Coordination of work procedures and by many other ways

By virtue of cost information in the hands of plant superintendents, department foremen, rate setters, and stock clerks there is at all times

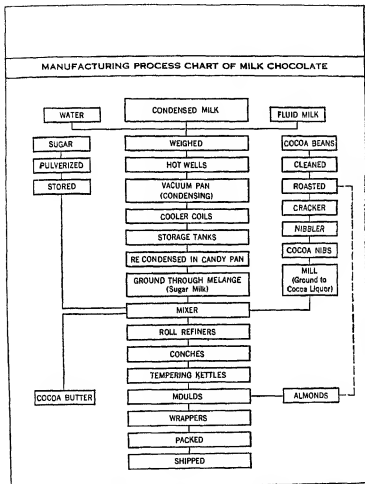


FIG 1 Chart Showing Manufacturing Processes Arranged as a Basis for Cost Records

a combined subconscious effort to reduce cost. Steady application of cost figures to factory operation becomes a natural part of the operating routine and savings are frequently put into effect which can be measured and discussed at meetings. In common with other business procedures cost figures soon become an accepted part of regular operation. Then value continues, when they serve as a specific control, year in and year out.

**To Price Products**—Competition sets selling prices. There are exceptions to this rule as in the case of a monopoly or where selling prices are created by statute. Obviously, selling prices in general are not established on the basis of production costs. From an economic sense while the total selling price in the aggregate must exceed total cost over a period of time there are many variations from this general rule. On the other hand many products are sold on the basis of cost estimates or actual production costs. An outstanding illustration is the sale of a product on a cost plus basis whereby the vendor receives the cost plus a stated percentage of profit. Where special products are sold, selling prices are frequently computed on the basis of production costs.

**To Provide Basis for Operating Policy**—Cost accounting plays an important part in the management of many manufacturing companies because of the fact that cost accounting is used as a basis for formulating operating policies. Among these policies are

- 1 Determination of break even point
- 2 Whether to shut down plant or operate at a loss
- 3 Whether to purchase certain parts or manufacture them

**ADVANTAGES OF COST ACCOUNTING**—Many limitations of financial accounting may be overcome by a well-designed cost accounting system. Among the advantages of cost accounting are

- 1 More accurate unit costs and knowledge of which results in the establishment of fair selling prices and in the elimination of unprofitable lines of product
- 2 Development of cost comparisons enabling the management to note unfavorable developments and to institute procedures for their elimination
- 3 Elimination of inefficiencies in plant operation. These inefficiencies are costly and are caused by material wastage, use of obsolete machinery, poor planning or assigning of men to work for which they are not qualified.
- 4 Presentation of more frequent and more accurate financial statements. Slow and costly methods of taking inventories are discarded and book inventories substituted under the cost system method of recording.
- 5 Increased operating efficiency through the establishment of standards and subsequent comparison of actual performance with established standards.
- 6 Establishment of control over material, labor and overhead expenditures.
- 7 Assisting in developing cost calculations for new products and designs to guide management in its efforts to determine the profitability of proposed changes in products and designs.

A tremendous amount of detail must be classified, recorded, and summarized if these advantages are desired. The net advantage obtained should exceed the cost incurred in obtaining additional information.



**COST OF PRODUCTION SCHEDULE**—One of the functions of the cost department is to assemble or allocate the expenditures incurred for material for labor, and for overhead. A summary statement of these costs is known as the cost of production schedule. This schedule assembles outlays occasioned by production orders set in motion by the plant superintendent. It is a summary of the cost accounts relating to the manufacturing activities and is a first step in computing the cost of goods sold as shown by the operating or profit and loss statement. This schedule is also called a manufacturing statement and takes the form shown in Fig 2 from Van Sicke (Cost Accounting). It may be modified to suit special conditions.

### STATEMENT OF PRODUCTION COST

JANUARY 1 19— TO JANUARY 31 19—

#### Direct Materials

Stores Inventory January 1		\$80 000 00
Purchases of Stores	\$29 777 00	
Reclaimed Materials and Scrap	14 00	
Total Charges to Stores during January		29 791 00
Total Stores Available for Use		\$89 791 00
Stores Inventory January 31		40 000 00
Total Stores Issued		\$49 791 00
Indirect Materials Used		1 791 00
Cost of Direct Materials Used		\$48 000 00

#### Direct Labor

18 000 00

#### Factory Overhead Expenses

Fuel	\$ 785 99	
Spoilage	136 00	
Heat	80 00	
Light	186 00	
Power	485 00	
Water	24 00	
Compensation Insurance	133 51	
Auto Repairs and Supplies	35 00	
Indirect Materials and Supplies	3 791 00	
Indirect Factory Wages and Salaries	8 702 00	
Medical Fees	100 00	
Machine Royalty Rentals	4 000 00	
Patents Amortization	170 00	
Depreciation Building and Equipment	2 006 00	
Insurance Building and Equipment	466 00	
Taxes Building and Equipment	489 50	

#### Total Factory Overhead Expenses

22 250 00

#### Production Charges Originating during January

\$70 250 00

#### Defective Work Credit

150 00

#### Net Production Charges

\$70 100 00

#### Work in Process Inventory January 1

6 000 00

#### Total Net Production Charges

\$76 100 00

#### Work in Process Inventory January 31

8 100 00

#### Cost of Production for January

\$68 000 00

Fig 2 Cost of Production Schedule or Manufacturing Statement

## Books and Records

**INFORMATION REQUIRED BY MANAGEMENT**—The essence of a satisfactory cost accounting system lies in the information obtained from the books and records that make up the system. The design of a system of cost records therefore depends largely on the results and information it is intended to provide. That is in planning the system it is essential to consider the information required by management and then to design it to furnish exactly that information. If complete and detailed historical cost information is to be provided for a number of products the system is of necessity extensive. If it is to be used principally as a device for control and reduction of costs as is the present trend predetermined or standard costs are used. All information regarding the product, plant production processes, etc., should be considered in terms of its contribution to the type of cost system management desires.

Another important consideration for those who work with the cost system lies in the **physical characteristics** of individual records themselves. Ledger sheets, inventory cards, time cards and other forms that are handled daily should be of substantial stock to withstand much wear and tear. They should be easy to post to and easy to understand. Printed forms should be designed to permit maximum use of duplicating devices where more than one form originates from one operation.

**FACTORY ORDERS**—A factory order is an authorization to the factory to commence specified operations. It is usually in written form so that misunderstanding as to specifications, purpose, time limitations, etc., may be avoided. The most commonly referred to factory order is the so-called production order, the two terms being frequently used synonymously. Occasionally it may also be designated as a **work order**. In continuous process or mass production plants the number of such production orders is limited. In job order plants, the number of production orders is usually much larger. A classification of **production orders** prepared by Dohr, Ingham, and Love (*Cost Accounting*) includes orders for

- 1 Finished goods for customers
- 2 Finished goods for stock
- 3 Finished parts
- 4 Repairs for customers
- 5 Repairs for the factory, usually called repair orders
- 6 Machinery and equipment for use in the plant, usually called betterment orders
- 7 Special work
- 8 Experimental work
- 9 Worked material
- 10 Disposition of defective work
- 11 Subproduction order where an order is split into parts

Newlove and Grunci (*Elementary Cost Accounting*) classify factory orders as

- A Production orders
  - 1 Special production orders for
    - a Finished product
    - b Component parts



SHOP ORDER									
ASSEMBLY NAME <u>Wing Channel</u>			ORDER No <u>A31-03</u>						
QUANTITY NEEDED <u>50</u>			ASSEMBLY No <u>19-03-01</u>						
ISSUED BY <u>John Smith</u>			MODEL <u>19</u>						
CHECKED BY <u>JD</u>			AIRPLANE Nos <u>101 to 149</u>		DATE <u>Aug 5, 19--</u>				
QUANTITY PER AIRPLANE	PART NO	DESCRIPTION	QUANTITY NEEDED	REQUISITION NO	FINISH SPECIF	TOOL NO	ESTIMATED MAN HOURS	DATE NEEDED	DATE COMPLETED
1	19-03-01 -03-02 -03-03 -03-04	<u>Metal Shop</u> Wing Channel Ribs Extrusions Gussets	150 100 300	6950 6950 6950	3 3 3	T1215 T2301 T1216	150	9/20/-	

Fig 4 Work or Shop Order Authorizing Assembly

The form of a cost sheet and kind of information contained thereon depends upon the nature of activities of the plant, needs of the management and the degree of control exercised over cost figures.

**DOUBLE ENTRY APPLIED TO COST KEEPING**—The information required under a cost system is secured by an extension of the double-entry bookkeeping rules of debit and credit. Double entry bookkeeping is based upon the fundamental principle of accountability for values. This means that if one dollar in cash is spent for material or service the new value received must be recorded and the value disposed of must likewise be recorded. An exchange of values takes place with the disposition of an old value for a new value.

Cost accounting, as a division of accounting, follows the same fundamental rules in accounting for values pertaining to factory operation. Monies are expended and in return materials, labor, and services classified as expenses such as power, heat and the like are received. At this point, cost accounting begins. Specific accounting procedures must be provided for recording the acquisition and disposition of materials for recording the employment and use of labor and for recording the incurring and distribution of expenses. Additional documents concerning operating activities must be prepared and recorded in the books of original entry. These books must be increased in number and be specially ruled to facilitate debit and credit recordings. Additional ledger control accounts are required and these in turn require the use of additional subsidiary ledgers in which the cost accounts may or may not be ruled in the conventional manner. New forms of business papers or documents, journals and ledgers must be developed in accordance with the requirements of the plant, and the needs of management. Tendencies towards standardization may be noted here and there, but, generally speaking there seems to be a noticeable lack of uniformity in the design of documents, journals, and ledgers used in cost accounting systems.

**BASIC DOCUMENTS**—Records and documents supporting historical cost transactions entered in journals and subsequently posted to ledgers are

- 1 Those relating to acquisition, storage and use of raw materials parts and supplies
- 2 Those relating to employment of labor activities payrolls etc. and to the use and performance of labor
- 3 Those relating to the incurring distribution and allocation of overhead to cost of production

**BOOKS OF ACCOUNT**—Under a cost system, cost transactions are recorded through a system of cost controlling accounts which may be kept in the general ledger or segregated in a factory ledger. Special records are used in the form of journals as well as ledgers.

**Journals**—If cost transactions are not summarized for recording in the general journal, they may be entered in separate journals prior to posting to ledgers. Separate journals may be used to record material requisitioned, labor used and overhead apportioned. In lieu of using a number of journals to enter costs, the system may provide for recording and accumulating all manufacturing costs in one factory or manufacturing journal.

Another method is to accumulate information on specially designed summaries which serve as a basis for **journal vouchers** at the end of the month. Such vouchers are then entered and posted through the general journal, or factory journal where a factory ledger is used.

**Ledgers**—In addition to a general ledger and the usual subsidiary ledgers of financial accounting, many additional subsidiary ledgers may be found in a cost system. These may include a stores ledger, a finished puts ledger, an overhead or manufacturing expense ledger, a plant ledger, a work in process ledger, and a finished goods ledger.

In some systems **controlling accounts** for these ledgers appear in the general ledger. However, the cost system may provide for a Factory Ledger Control account thereby eliminating a number of control accounts from general ledger.

**RECORDS UNDER GOVERNMENT CONTRACTS**—According to Treasury Decision 5000 the following requirements constitute compliance with the law.

Each contracting party is required by law to make a report of its true profits and excess profit. Such party must therefore maintain such accounting records as will enable it to do so. Among the essentials are the following:

- 1 The profit or loss upon a particular contract or subcontract shall be accounted for and fully explained in the books of account separately on each contract or subcontract.
- 2 The accounts shall clearly disclose the nature and amount of the different items of cost of performing a contract or subcontract.

All books, records and original evidences of costs (including among other things production orders, bills or schedules of materials, purchase requisitions, purchase orders, vouchers, requisitions for materials, standing expense orders, inventories, labor time cards, payroll, cost distribution sheets) pertinent to the determination of the true profit, excess profit, deficiency in profit or net loss from the performance of a contract or subcontract shall be kept at all times available for inspection by internal revenue officers and shall be carefully preserved and retained. This provision is not confined to books, records, and original evidences pertaining to items which may be considered to be a part of the cost of performing a contract or subcontract. It is applicable to all books, records and original evidences of costs of each plant, branch or department involved in the performance of a contract or subcontract or in the allocation or distribution of costs to the contract or subcontract.

A special Government Bulletin issued by the War and Navy Departments, to explain in part the provisions of T.D. 5000 states that no particular accounting system is required on the part of the contractor. The only requirements are:

- 1 That it is in accord with generally accepted and sound accounting practices.
- 2 That the cost calculation produce correct figures consistent with the above mentioned principles.
- 3 That the cost accounts be under the control of the general accounts. In this connection the Bulletin states:

By this is meant that the accounting procedure should be such that there is a definite control through ledger accounts set up for the

purpose over all the detailed accounts in which the costs are distributed. Cost accounts separately kept without such suitable proof of control are seriously open to question.

Where the nature of the business has not changed materially by the shift to war production the method of cost determination customarily employed by the contractor is presumably satisfactory. However, where there has been a radical change in shifting from peacetime to wartime production new methods of distribution and cost determination may have to be employed.

## Cost Controls and Subsidiary Ledgers

**CONTROL ACCOUNTS**—A controlling account is an account kept in a major ledger whose balance represents in a single sum the details contained in two or more accounts of the same nature as the control but which are kept in a subsidiary ledger. Postings to detailed accounts in a subsidiary ledger must ultimately be reflected in postings to control accounts, usually lump sum postings made at end of a period.

Cost control accounts kept in a general or factory ledger are defined by Van Sicke (Cost Accounting) as "accounts in which are recorded the transactions that pertain to the production and marketing functions of a business enterprise."

Below are shown important cost controls and their respective subsidiary ledgers:

CONTROL ACCOUNT	SUBSIDIARY LEDGER
1 Stores	1 Balance of Stores Ledger
2 Work in Process	2 Job Order Cost Sheets or Process Ledger
3 Finished Parts	3 Finished Parts Ledger
4 Finished Goods	4 Finished Goods Ledger
5 Actual Manufacturing Expense	5 a Primary Expense Ledger b Departmental Expense Ledger or Expense Distribution Sheet

Fig 5 taken from Gillespie (Introductory Cost Accounting) shows the relation of control to subsidiary ledgers for a job order system. The accounts illustrated are inventory accounts, the subsidiary ledgers therefore, constitute book or perpetual inventories.

In general, accounts appearing in a factory ledger represent manufacturing control accounts. Some of these are not technically controlling accounts since there is no subsidiary ledger to support them. This group of accounts is sometimes referred to as reflecting the manufacturing cycle since the accounts are so arranged as to trace the flow of costs from raw materials through Work in Process, Finished Goods and Cost of Sales. When finished goods are sold, new supplies of raw material are required to start a new cycle.

**Principal Cost Controlling Accounts**—The most important cost controls and their method of operation appear below.

## STORES

Inventory at beginning	Direct Materials Issued
Purchases	Indirect Materials Issued
Returned Material	Returns to Supplier
Scrap	Balance (Inventory at end)
Returns from Production	

## WORK IN PROCESS

Inventory at beginning	Cost of Completed Production
Raw Materials Used	Finished Units
Finished Parts Used	Unfinished Cost
Direct Labor Used	Spoilage and Returned Materials
Manufacturing Expense Applied	Returns of Unused Raw Materials
	and Put to Stores
	Balance (Inventory at end)

## FINISHED PARTS

Inventory at beginning	Returns to Suppliers
Cost of Completed Unit from Work in Process	Returns to Work in Process (on assembly order)
Cost of Completed Parts Purchased	Cost of Goods Sold (for parts sold directly)
Returns from Production	Balance (Inventory at end)
Returns from Customers	

## FINISHED GOODS

Inventory at beginning	Cost of Goods Sold
Cost of Completed Production	Balance (Inventory at end)
Returns from Customers	

## COST OF SALES

Cost of Shipments to Customers	Overapplied Manufacturing Expense
Underapplied Manufacturing Expense	Cost of Returns from Customers
	Balance to P & I

## ACTUAL MANUFACTURING EXPENSE

Cost of Indirect Material Used	Transfer from Applied Expense
Cost of Indirect Labor Used	Balance to Over and Underapplied
Expenses Incurred through Voucher Register	Manufacturing Expense
Fixed Charges such as Taxes Insurance Depreciation etc	
Balance to Over and Underapplied Manufacturing Expense	

## ALLOCATED MANUFACTURING EXPENSE

Closed into Actual Manufacturing Expense	Estimated Expense Charged to Work in Process
--	--

**SUBDIVISIONS OF WORK IN PROCESS**—Subdivision of the Work in Process account may be on the basis of

- 1 Elements of Cost
- 2 Departmental Costs





Where Work in Process is divided according to elements (and on and on, (Principles of Cost Accounting) how the accounts is follows:

#### MATERIAL IN PROCESS

Cost of material on hand at the beginning of the period	Cost value entered on the completed finished parts and finished goods orders at the same time debit Finished Parts and Finished Goods accounts
Direct materials issued during the period for production orders at the same time credit Stores account	Cost value of materials returned to stores at the same time debit Stores account
Finished parts issued during period for sub-assemblies and finished goods at same time credit Finished Parts account	

The balance of this account represents the amount of materials in process or unfinished work and should agree with the material costs on various cost sheets of unfinished orders

#### LABOR IN PROCESS

Cost of direct labor in process at the beginning of the period	Cost of direct labor on the completed finished parts and finished goods orders at the same time debit Finished Parts and Finished Goods accounts respectively
Direct labor applied to production orders during the period at the same time credit Payroll account	

The balance of this account represents the amount of direct labor in process and should agree with the direct labor section on the various cost sheets of unfinished orders

#### MANUFACTURING EXPENSE IN PROCESS

Applied expense in process at the beginning of the period	Expense applied to the completed finished parts and finished goods orders at the same time debit Finished Parts and Finished Goods accounts
Expense applied to production orders during the period at the same time credit Manufacturing Expense account	

The balance of this account represents the amount of applied expense in process and should agree with the manufacturing expense section on the various cost sheets of unfinished orders

The distinguishing features of departmental work in process accounts are

- 1 A separate Work in Process account is opened for each cost center or department
- 2 Interdepartmental transfers may be made by debiting the department receiving work and crediting the department from which work is transferred

In all other respects these accounts are operated in the same way as a single Work in Process account, i.e. they are debited for direct material

labor consumed and overhead incurred in the particular department or cost center. Such accounts are particularly common in process costs.

**TEMPORARY COST ACCOUNTS**—Sometimes intermediate cost accounts are employed. They are transitional or temporary accounts, which are always closed out before trial balance time. Thus Van Sickle (*Cost Accounting*) shows accounts for

- 1 Direct Material Used
- 2 Direct Labor
- 3 Factory Payroll

Use of such accounts may be advisable where departmental work in process accounts are employed. In such cases the accounts listed above are opened, and after being analyzed, then balances are closed into appropriate departmental work in process accounts through suitable journal entries.

**GENERAL RECORDS AND COST RECORDS**—Details of costs which appear in cost accounts must be coordinated with the general books of the organization, otherwise lack of control results and it becomes impossible to determine whether cost records and reports have been prepared accurately. This can be remedied by dovetailing the cost records into the general records by means of controlling accounts. The diagram from Van Sickle (*Cost Accounting*) presented in Fig 6 shows the cost control accounts required, then relation to each other and to the general accounts. Subsidiary ledgers furnish detailed figures supporting each control account. The diagram may also be used as a flow chart of production costs.

## Factory Ledger and Journal

**SELECTION OF FACTORY RECORDS**—The size of a company and its physical layout govern the selection of factory records. In small or medium sized companies the cost or factory records are subject to controlling accounts carried in the general ledger. In larger companies and companies with factory branches factory ledgers are used to relieve the general ledger from carrying individual factory control accounts. The factory ledgers then contain individual factory accounts, such as labor, burden, and other accounts under factory jurisdiction.

**Disadvantages of Single Ledger**—The practice of keeping all control accounts in one general ledger involves disadvantages. These are stated by Amidon and Long (*Essentials of Cost Accounting*) to be

- 1 The number of accounts in the general ledger tends to become unnecessarily large.
- 2 The preparation of the monthly statements may be delayed since all figures must go through one ledger to appear eventually in the trial balance.
- 3 Administrative difficulties may arise due to the separate location of the factory and office. Where the general office must hold its books open until the factory reports are received the ensuing monthly statements may be so delayed as to lose a great deal of their value as indices of current business progress.

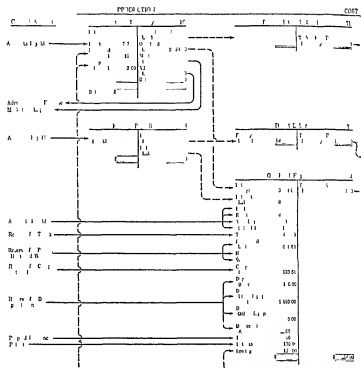


FIG 6 Relation of General



The introduction of a **factory ledger** solves these difficulties. Based on the principle of division of labor, it permits different persons to work independently on the general and factory ledgers. It also aids in the preservation of a certain amount of secrecy, since no one person is entrusted with all the information.

**DUAL CONTROL ACCOUNTS**—A factory ledger is a complete, self-balancing ledger coordinate with rather than subordinate to the general ledger. Hence, a trial balance of accounts in this ledger is added to the trial balance of accounts appearing in general ledger. Where a factory ledger is used, it is necessary to remove the cost controls from general ledger and incorporate them in the factory ledger. In order to

FACTORY LEDGER CONTROL (maintained at general office)					
19- Feb 1	Inv stores	4 81 5	19- Feb 1	Journal voucher	
	Disbursement voucher			Cost of goods sold	788 45
	Rent	18 50			
	Labor	816 40			
	Material and expense	5 18 01			
	Journal voucher				
	Payroll tax accrued	8 10			
	Insurance tax and depreciation	131 11		Balance down	67 1
		4 95 11			4 95 11
Mar 1	Inv stores	4 11 0			

GENERAL LEDGER CONTROL (maintained at factory office)					
19- Feb 1	Journal voucher		19- Feb 1	Inv stores	4 81 55
	Cost of goods sold	788 45		Disbursement vouchers	
				Rent	187 50
				Labor	816 40
				Materials and expense	5 18 01
				Journal vouchers	
				Payroll tax accrued	8 10
				Insurance tax and depreciation	131 11
	Balance down	67 1			4 95 11
		4 95 11			
Mar 1	Inv stores	4 11 0			

FIG 7 Dual Ledger Controls

make both ledgers self-balancing a new account is introduced in each ledger:

- 1 In the general ledger: Factory Ledger Control account
- 2 In the factory ledger: General Ledger Control account

Typical appearance of these **reciprocal accounts** is shown by Gillespie (Introductory Cost Accounting) Fig 7. Note that the debit balance in one account exactly matches the credit balance of the other.

**ACCOUNTS APPEARING IN FACTORY LEDGER**—If the General Ledger Control account is to be debited or credited as a result of a transaction, data must be reported to the home office or general accounting department in order that a reciprocal control entry may be made. If the factory control account upon the general books is to be debited or credited the information must be recorded in the factory books inasmuch as the controls must be in agreement at all times.

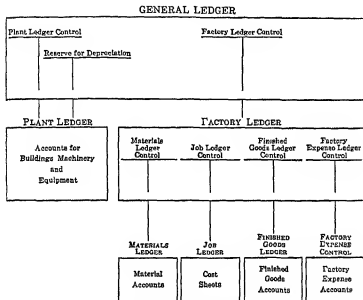


FIG. 8 Relationship of General Ledger to Factory Ledger

The most important accounts kept in the factory ledger are

- 1 Stores
- 2 Factory Supplies
- 3 Finished Parts
- 4 Direct Labor, if such an account is to appear
- 5 Payroll Accrued
- 6 Manufacturing Expense—Actual
- 7 Manufacturing Expense—Applied
- 8 Work in Process
  - a Material in Process
  - b Direct Labor in Process
  - c Manufacturing Expense in Process

- 9 Finished Goods
- 10 General Ledger Control
- 11 Cost of Sales
- 12 Additional accounts such as
  - a Factory Petty Cash
  - b Payroll Cash
  - c Some operating reserves etc.

### RELATIONSHIP OF GENERAL AND FACTORY LEDGERS

—The relationship between the general ledger and the factory ledger is

MULTI COLUMN									
Date	Particulars	General Ledger Control		Materials		Materials in Process		Lab. in Pro.	
		Dr.	Cr.	Dr.	Cr.	Dr.	Cr.	Dr.	Cr.
19--									
Feb. 1	To open factory ledger	\$	\$ 4 781 88	\$ 500 00	\$	\$ 00 00	\$	\$	\$ 25 00
	1 Rent voucher from general office		187 50						
	* Labor Journal vouchers to general office		214 40						456 40
	* Materials and expense disbursement vouchers to general office		\$ 836 01	\$ 200 00					
28	Payroll tax Journal voucher to general office		\$ 16						
28	Insurance, taxes and depreciation Journal vouchers from general office		200 33						
28	Factory expense applied to production								
28	Materials used			1 350 00		1 300 00			
28	Goods completed						900 00		
28	Cost of goods sold	\$ 2 781 26							
		\$ 2 781 26	\$ 9 462 88	\$ 3 700 00	\$ 1 350 00	\$ 1 300 00	\$ 900 00	\$	\$ 481 40

FIG. 9 Multi Column

illustrated by Gillespie (Introductory Cost Accounting) Fig. 8. Note that the general ledger and in this case, the plant ledger which contains the building and equipment accounts are kept at the general office.

The ledgers kept at the factory office are

- 1 Materials Ledger
- 2 Work in Process Ledger
- 3 Finished Goods Ledger
- 4 Factory Expense Ledger



**FACTORY JOURNALS**—Factory journals are required as media for postings to the factory ledger. Fig 9, from Gillespie (Introductory Cost Accounting), shows a multi-column factory journal used to summarize factory journal vouchers or memos forwarded by the home office to the factory. Postings of amounts appearing in the factory journal are made in the usual manner to accounts appearing in the factory ledger and to accounts in ledgers subsidiary to the factory ledger. Where numerous entries come from many sections of the works accounting department the columnar journal combines those entries and reduces

FACTORY JOURNAL										
or date	Factory Expense in Process		Finished Goods		Factory Expense		Sundry Accounts			
	Dr.	Cr.	Dr.	Cr.	Actual	April 4	Name	No.	Dr.	Cr.
\$	\$ 56 56	\$	\$ 4 000 00	\$	\$	\$			\$	\$
					137 50					
					250 00					
					126 01					
					\$ 16					
					\$32 55					
	917 40					917 40				
121 40		250 75	1 521 75		50 00					
\$ 121 40	\$ 917 55	\$ 250 75	\$ 5 251 75	\$ 2,738 25					\$	\$
					\$ 1 076 00	\$ 917 40				

Factory Journal

the number of postings to each factory ledger account. The factory journal becomes an analysis of all manufacturing entries month by month as well as a book of original entry, and the ledger becomes mainly a "long time" book of control totals.

Other journals used at the factory might include

- 1 Requisition Journal
- 2 Summary of Factory Disbursement Vouchers
- 3 Finished Goods Journal
- 4 Cost of Sales Journal

# OPERATION OF FACTORY LEDGER—Illustrative transactions used by Gillespie (Introductory Cost Accounting) to show the operation of a factory ledger are shown herewith

## AT THE GENERAL OFFICE

(Entries posted to the general ledger)

Entries to Open factory ledger	
Factory Ledger Control	\$4 81 50
Materials	\$ 500 00
Materials in Process	.00 00
Labor in Process	75 00
Factory Expense in Process	.00 00
Finished Goods	36 50
To close inventory accounts to new factory ledger	4 000 00
	\$4 781 55

## AT THE FACTORY OFFICE

(Entries posted to the factory ledger)

Entries for Expense Bill received at general office and charged to factory	
Factory Ledger	187 50
Voucher Payable	187 50
Issue voucher for factory rent	
Factory office	
Vouchers Payable	187 50
Cash	
Payment of voucher	187 50
To open new factory ledger	
Materials	\$ 500 00
Materials in Process	.00 00
Labor in Process	75 00
Factory Expense in Process	.00 00
Finished Goods	36 50
General Ledger Control	4 000 00
	\$4 781 55

Entries for Factory Payroll computed in factory payroll office and passed to general office for payment	
Factory Ledger Control	816 40
Due Factory Cashier	15 00
Payroll Tax Accrued	8 16
Due Company Store	14 00
Accrued Wages	779 24
Journal vouchers for factory payrolls received from factory	
Due Factory Cashier	15 00
Accrued Wages	779 24
Vouchers Payable	794 24
To issue disbursement vouchers for factory payrolls (to reimburse factory cashier for advances to employees and to provide pay master with funds)	
Vouchers Payable	332 70
Cash	352 70
Checks sent to factory cashier and pay master (last payroll of month is not yet paid)	

Labor in Process	
Factory Expense	456 40
General Ledger Control	360 00
Weekly hourly payrolls and monthly salary roll journal vouchers to general office	516 40

Entries for Materials and Expenses verified and vouchered at factory and passed to general office for payment

Factory Ledger Control	\$3 336 01	Materials	\$3 200 00
Vouchers Payable		Factory Expense	136 01
To take up disbursement vouchers received from factory		General Ledger Control	\$3 336 01
		Issue vouchers for inhibitors verified at factory and passed to general office for payment.	
		Particulars	Amount
		Materials	\$3 900 00
		Repairs	30 00
		Power	6 01
		Total	\$3 336 01
Vouchers Payable	50 00	No entry	
Cash			
Paid voucher for repair (factory)	50 00		

### Entry for Selling and General Payroll

Selling and General Expense  
Payroll Tax Accrued  
Accrued Salaries  
Sales and office salaries for month

400 00	No entry
4 00	
296 00	

### Entries for Payroll Tax Employer's Liability

Factory Ledger Control	8 16	Factory Expense	8 16
Payroll Tax Accrued		General Ledger Control	
To take up employer's own liability for payroll tax on factory payroll		To transmit employer's own liability for payroll tax on factory rolls to general office	
4 00			
Selling and General Expense		No entry	
Payroll Tax Accrued			
To record employer's own liability for payroll tax on sales and office rolls			



A trial balance of the factory ledger at the end of the month is as follows

TRIAL BALANCE—FACTORY LEDGER  
FEBRUARY 28 19—

Materials	\$2 350 00	
Materials in Process	600 00	
Labor in Process	500 00	
Factory Expense in Process	713 00	
Finished Goods	2 543 50	
Factory Expense	1,075 00	
Factory Expense Applied		\$ 917 40
General Ledger Control		6 724 70
	<u>\$7 042 10</u>	<u>\$7 042 10</u>

### Voucher Register

#### DEFINITION AND NATURE OF VOUCHER REGISTER—

A voucher register may be defined as a book of original entry in which a record is made of all transactions which result in a disbursement of cash. It is a combination purchase journal and creditors' ledger. As a purchase journal it serves as a medium for recording liabilities incurred for goods as well as services and by keeping track of individual invoices or vouchers it eliminates the necessity for a creditors' ledger.

The voucher register also serves as a centralized record for the classification of expenditures of a period. As stated by Dohi Ingham, and Love (Cost Accounting)

When used in its most comprehensive form all expenditures of whatever kind or nature are entered here on incurrence and distributed or charged through the various distribution columns. Where the voucher register is not used or where it is used in incomplete form it may be supplemented by the purchase journal, the expense journal and a certain amount of analysis may be made in the cash disbursements journal.

Thus the voucher register serves as a **cost classification register** in a manufacturing plant. It is important because through its distribution columns a flow of costs is started resulting in postings to cost controlling accounts and then underlying records. By so centralizing all liabilities, no payments can be made, i.e., no check drawn, unless a voucher has been prepared, properly entered, and authorized for payment.

The voucher register is part of a **voucher system**, which in turn is part of a system of internal check.

**DEFINITION OF VOUCHER**—In nontechnical language, a voucher is often assumed to be any business paper prepared as a result of a business transaction. It may be an invoice, a check, a receipt (e.g., petty cash voucher) etc. In a technical sense however, a voucher is a document prepared by someone within the business, authorizing a bookkeeper to make an entry in some book of account, usually the voucher register or some journal. Thus a **journal voucher** represents an authorization to prepare a journal entry. A **purchase voucher** similarly forms the basis for an entry in the voucher register and represents a formal recognition of the incurrence of a liability, to be liquidated by

subsequent payment by check. It is prepared on the basis of a purchase invoice for materials, supplies, expense items for services etc. originating from without the plant, also as a result of internal transactions, such as payrolls, petty cash reimbursements, etc.

**VOUCHER SYSTEM**—The voucher system includes all documents, records, and procedures in connection with the incurrence and liquidation of liabilities. Documents and records include

- 1 Purchase invoices or expense bills, payroll summaries, etc.
- 2 Purchase voucher or voucher check
- 3 Voucher register
- 4 Check register
- 5 Voucher index of creditors

These provide complete opportunity for auditing and recording of liabilities, their liquidation, and control over disbursements. The purpose of a voucher system is

- 1 To provide economy in handling and recording purchases of goods or services
- 2 To provide means for correct charges to accounts representing purchases of goods or services
- 3 To secure specific receipts for specific invoices in order to
  - a Minimize fraud
  - b Avoid double payment of same bills
- 4 Secure control over volume of disbursements

**SOURCES OF VOUCHERS**—The following give rise to the preparation and issuance of vouchers

- 1 Purchase of raw materials or supplies
- 2 Payrolls
- 3 Overhead expense
- 4 Selling expense
- 5 Administrative expense
- 6 Purchase of fixed assets
- 7 Summary of petty cash disbursements as basis for reimbursement of fund
- 8 Payment of notes
- 9 Other transactions requiring payments by check


**PREPARATION OF VOUCHER**—When an invoice or other document evidencing a liability is received, it must be thoroughly audited and a voucher prepared. Preparation of a separate voucher for each invoice involves, however, much work, hence the modern method is to short cut the entire process by preparing the voucher and check in a single operation.

Figs 10a and 10b show a combination check and voucher. Fig 10a is the check, it is hinged to Fig 10b by perforations, and when folded over, completely covers the upper part of the voucher. A carbon of the same size as the check is inserted between the check and the voucher. When an invoice has been audited, the name and address of the creditor or payee are typed in and the details of the invoice recorded in the proper space on the check. All these documents are then filed away in a voucher jacket. This is a kind of folder, one being maintained for each creditor. If during the course of the month additional invoices are received and audited from the same creditor, the check and voucher



are taken out of the folder and the additional invoice typed in the invoice space. At the end of the month or whenever time for payment is at hand the invoices recorded on the check are totaled, amount and date typed in and submitted for approval. The original after approval, is detached, recorded in the check register, and mailed to the payee. The duplicate which serves as a voucher is analyzed as to accounts to be charged in the space provided therefor and entered in the voucher register. Accounts to be charged are determined by reference to the original requisition or official chart of accounts.

Another form of **voucher check** (Fig 11) consists of a check and a detachable remittance memorandum. It is prepared at the same time the

<b>R T VANDERBILT CO INC</b> 100 PARK AVENUE NEW YORK				<b>No 34226</b> <b>2</b>
PAY <u>111.10/100</u> TO THE ORDER OF				November 21, 1942 DOLLARS <u>111.10</u>
THE NICHOLS PRESS COMPANY 15 E. 42nd Street New York N.Y.				R T VANDERBILT CO INC.  President
TO THE NATIONAL CITY BANK, NEW YORK				ANY BANK

R T VANDERBILT CO INC				No 34226			
10809	11/19/42	13366	6 21	ON	DO	CHECK	6 1

Fig 11 Voucher Check with Detachable Remittance Statement

voucher is drawn up. When the obligation is due, the check is signed and forwarded to the creditor. Thus voucher checks not released constitute the equivalent of an **accounts payable** ledger. If desired the vouchers may serve as a check register.

Where check and voucher are not prepared simultaneously, a more elaborate **voucher jacket** is required. Fig 12 taken from Dohi, Inghram, and Love (*Cost Accounting*) shows the outside and inside of a voucher jacket. The inside contains the detailed distributions of the invoices; the outside a summary of these distributions.



<b>ATTACH CREDITOR'S INVOICES HERE PERMANENTLY ALSO PURCHASE ORDER RECEIVED REPORT AND INSPECTION REPORT</b>	Accounts To Be Charged													
											Amount			
										Date				

Words N _____			
<b>THE AMERICAN MFG CO</b>			
TO _____			
D E _____ P d by Check No _____ P O d N _____			
Ac c o u n t	L F	B a l a n c e	C o d e
P a y e e C h e c k e d b y _____ E x a m i n e d b y _____ R e c e i v e d b y _____ I n s p e c t e d b y _____  A p p r o v e d F o r P a y m e n t _____  E x d i v i d e n t _____			

*Inside before folding**Outside after folding*

FIG 12 Voucher Form

**FORM OF VOUCHER REGISTER**—The form of the voucher register is not standardized. Fig 13 from Blocker (Cost Accounting) illustrates a common form of register which is also used as an accounts payable ledger. Unpaid accounts payable can be determined at any time by listing the open items in the Check Number column. One feature of this form is that it has a **Code Number** column in connection with each distribution column. Under this plan analyses of columns are made monthly and postings made from the analyses. Use of a code column and subsequent analyses reduces the number of distribution columns otherwise required and hence reduces the bulkiness of the voucher register.

[illegible]

Fig 13 Voucher Register

If a factory ledger is used, columnar headings in the voucher register representing factory ledger accounts are omitted, and then place is taken by a single column headed "Factory Ledger." Vouchers after entry in the general office voucher register are turned over to the cost department for entry either in a factory office voucher register, or in a factory journal. These books contain a credit column "General Ledger" and the necessary distribution columns.

**VOUCHER DISTRIBUTION**—Where analysis is extensive, specially prepared analysis forms may be used. Fig. 14 shows a special voucher distribution sheet used by General Electric Co.

VOUCHER DISTRIBUTION					
PAYER.....			VOUCHER NO. ....		
			MONTH.....		
ACCOUNT	AMOUNT	TOTAL	ACCOUNT	AMOUNT	TOTAL

FIG. 14 Voucher Distribution Sheet

The following outline sets forth the principal features of the voucher and purchase distribution system in use by the Michigan Alkali Company.

1 The usual forms of voucher register, columnar distribution check register, and postings thereto have been eliminated. Except for summary journal entries at the end of each month a voucher check and a distribution ledger constitute the entire record of vouchers payable. A voucher check (similar to that shown in Fig. 11) consists of an original for the vendor, a duplicate punched for filing in a post binder to serve as check register, and a triplicate to attach to supporting invoices and other data for filing alphabetically.

DISTRIBUTION LEDGER						
Sheet No. 1			ACCOUNT NO. 7921			
FOR MONTH OF JANUARY 1941			ACCOUNT NAME STATIONERY AND OFFICE SUPPLIES			
HY. NO.	NAME	DEBTS	DEBTS	LD. LANE	LANE	
1105	JOHN DOE CO	1115				
1195	R. SMITH CO	234				
1925	OFFICE SUPPLY CO	2465		13 49	3814 --	
2503	J. BROWN CO	1922				
2917	JOHN DOE CO	3502		3814	9236 ~	

FIG. 15 Distribution Ledger

ACCOUNTS PAYABLE																			
SUPPLIER	CO	INVOICE DATE			DUE DATE			INSTR. NO.		BUDGET		VOUCHER NUMBER	FINAL DISC		CREDIT OR DEBIT	DATE PAID	PAID BY		REGR/N
		N	D	Y	M	D	Y	CL	ITEM	CL	ITEM		CONT	CL/ISS	DEPT	M	D	Y	
000000	00	00	00	00	00	00	00	00	00	00	00	000000000000	000000000000	000000000000	000000000000	000000000000	000000000000	000000000000	000000000000
111111	11	11	11	11	11	11	11	11	11	11	11	111111111111	111111111111	111111111111	111111111111	111111111111	111111111111	111111111111	111111111111
222222	22	22	22	22	22	22	22	22	22	22	22	222222222222	222222222222	222222222222	222222222222	222222222222	222222222222	222222222222	222222222222
333333	33	33	33	33	33	33	33	33	33	33	33	333333333333	333333333333	333333333333	333333333333	333333333333	333333333333	333333333333	333333333333
444444	44	44	44	44	44	44	44	44	44	44	44	444444444444	444444444444	444444444444	444444444444	444444444444	444444444444	444444444444	444444444444
555555	55	55	55	55	55	55	55	55	55	55	55	555555555555	555555555555	555555555555	555555555555	555555555555	555555555555	555555555555	555555555555
666666	66	66	66	66	66	66	66	66	66	66	66	666666666666	666666666666	666666666666	666666666666	666666666666	666666666666	666666666666	666666666666
777777	77	77	77	77	77	77	77	77	77	77	77	777777777777	777777777777	777777777777	777777777777	777777777777	777777777777	777777777777	777777777777
888888	88	88	88	88	88	88	88	88	88	88	88	888888888888	888888888888	888888888888	888888888888	888888888888	888888888888	888888888888	888888888888
999999	99	99	99	99	99	99	99	99	99	99	99	999999999999	999999999999	999999999999	999999999999	999999999999	999999999999	999999999999	999999999999
101010	10	10	10	10	10	10	10	10	10	10	10	101010101010	101010101010	101010101010	101010101010	101010101010	101010101010	101010101010	101010101010

Fig 16 Punched Card Used as Accounts Payable and Cost Distribution Record

2 A separate distribution ledger card (Fig. 15) is used for each expense or other account to which distribution is made. These cards reflect a detailed analysis for postings to each account. To voucher an approved invoice for payment requires two entries on the bookkeeping machine:

- a Entry to voucher check
- b Entry to distribution ledger

**Punched Card Distributions**—Some concerns have abolished use of a formal invoice or voucher register. Information on the voucher is punched to a card (Fig. 16). Sorting and tabulation of the cards yields data for the summary entry and detailed postings to the distribution accounts. When the volume of remittances is sufficiently large tabulating card voucher checks (Fig. 17) may be drawn through use of an automatic summary punch. This involves a fully automatic disbursement routine.

FIG. 17 Tabulating Card Voucher Check

**OPERATION OF VOUCHER REGISTER**—Vouchers after being audited are turned over to the voucher register clerk (sometimes called accounts payable clerk) for entry in the voucher register. Each voucher, whether it represents a single invoice or a group of invoices from the same creditor, is entered in the Voucher Payable column, and carried to the proper distribution (debit) column. This automatically credits a control account variously called Vouchers Payable, Audited Vouchers Payable or merely Accounts Payable. At the end of the period, the columns are totaled and proved by cross-footing to check the equality of debits and credits. A summary entry may then be made in the voucher register. Based on Fig. 13, it would read as follows:

Raw Materials	\$
Factory Supplies	
Payrolls	
Factory Overhead	
Selling Expenses	
Administration Expenses	
Machinery and Equipment	
Supplies	
Vouchers Payable	\$

To summarize audited vouchers for month of

Postings are made from the summary except the Sundries item, the latter is individually posted. Where controls are broken down into sub accounts detailed postings are made from special analyses similar to the provision made in Fig 12 or else a summary analysis may be prepared on a work sheet. **Summary entries** however, are not essential. Postings may be made directly from columnar totals.

When vouchers are paid they are checked off in the voucher register by placing the check number and date of payment opposite the voucher in the liquidation column. Therefore any blank spaces in that column represent unpaid vouchers. By listing and totaling the amount of these vouchers proof of accounts payable is established since the total of the list must equal the balance of the control account. In those cases where invoices are vouchered and entered in the voucher register immediately after being audited an independent check of unpaid vouchers may be had by checking with the voucher jacket file.

**FORM AND OPERATION OF CHECK REGISTER**—A check register which is an integral part of a voucher system is a cash disbursement book listing checks drawn in payment of vouchers. It operates as a record of checks released if a voucher check system is in use. The only money columns necessary are

- 1 Net Cash
- 2 Purchase Discount
- 3 Accounts (or Vouchers) Payable

The summary entry at end of month is

Accounts Payable	\$	\$
Cash		
Purchase Discount		

**UNAUDITED VOUCHERS**—At all times there are many purchase invoices which have not been completely audited, and are therefore not as yet entered in the voucher register. Since most concerns keep their books on an accrual basis it is necessary to summarize all such items and make an adjusting entry by debiting various inventory and expense accounts and crediting some such account as Sundry Liabilities or **Unaudited Accounts Payable**. After the books are closed, this entry is reversed and thereafter invoices when fully audited are put through their normal procedure.

**FILING OF PAID VOUCHERS**—After vouchers are paid, they are filed usually in numerical order. This gives no opportunity to trace vouchers for specific creditors where their numbers are unknown. Since no creditors' ledger is kept, it is therefore advisable to organize an alphabetical creditors index file. The card for each creditor shows

- 1 Voucher number
- 2 Date
- 3 Amount

Vouchers are posted by file clerks to these cards. In effect this is the equivalent of keeping a loose-leaf creditors' ledger. Hence any possible labor-saving occasioned by the elimination of a creditors' ledger is nullified. Moreover, the accuracy of the file is open to question, since its content is not part of the work performed by the bookkeeping staff, and therefore is not subject to the ordinary checks for accuracy.

Where duplicate vouchers are retained by the debtor, one may be filed numerically, the other alphabetically. The numerical file includes all documents relating to the voucher. As stated by Blocker (Cost Accounting)

It is customary in many concerns to have the canceled checks attached to the vouchers after the returned checks have been audited by the accounting division. The voucher with the supporting papers, approvals and the canceled check constitute all the necessary informational base and evidence of the liability and payment that any auditor would require.

Sometimes a special form of voucher jacket known as a **voucher backer** is used for this purpose. Fig 18 shows such a form used by a manufacturer of restaurant kitchen equipment.

### SPECIAL PROBLEMS IN USE OF VOUCHER REGISTER

—Use of a voucher system requires a voucher as authority for each payment. The voucher system operates most satisfactorily when bills are paid by check, in full, promptly and when returns and allowances relating to recorded vouchers are few in number. Special problems arise in connection with

- 1 Partial payments
- 2 Returns and allowances
- 3 Payment by notes, drafts, etc.
- 4 Delayed payments

**Partial Payments**—Invoices and vouchers should so far as possible be paid in full. Where that becomes impossible, it is best to cancel the original voucher and issue two new ones in its stead. The first new voucher is for the current payment, the second for the unpaid balance. A slight variation of this method is described by Hatfield, Sanders, and Burton (Accounting Principles and Practices) as follows:

The original invoice is vouchered in the customary manner and entered in the voucher register. The amount of the partial payment is entered in the check register and the number of the voucher to which the payment is applicable is indented in the appropriate column. A new voucher is prepared for the unpaid portion of the debt and when entered in the voucher register appears as a credit and a debit to Accounts Payable, the debit being entered in the Miscellaneous column. In the "How and When Paid" column, on the line of entry of the original voucher, are now entered both the number of the check issued in part payment of it and the number of the new voucher prepared for its unpaid portion. Thus the complete cancellation of the first voucher is accomplished without omitting the liability for the difference between it and the check issued in part payment of it.

If partial payments become at all extensive, it is best to use the voucher register as a **purchase journal** supported by a creditors' ledger. The other features of the voucher system may of course be retained.

**Purchase Returns, Allowances, and Other Credits**—Defects in the quality of goods received, errors in pricing, etc., do not affect, as a rule, the books of account, since most of these items are revealed in the process of auditing before vouchering and entry in the books. Where, however, entries have been made and it becomes necessary to return goods to a supplier or ask for allowance, this is evidenced by receipt of a credit memo from the supplier or issuance of a **voucher charge** by the pur-





chaser. The latter is similar to a voucher but of a different color and is entered in the voucher register in red ink, thus reversing debits and credits. A copy of the voucher charge is attached to the original voucher to prevent overpayment. A statement may appear on the voucher charge informing the supplier that it is unnecessary to issue a credit memo.

Another method is to cancel the original voucher and issue a new one for the reduced amount. The entry is as follows:

Vouchers Payable (No. 62)	\$575	
Vouchers Payable (No. 89)		\$540
Stores (or other account)		35

The debit appears in the Sundries column, the credit to Vouchers Payable in the usual column, and the credit to Stores or other account in red ink in the appropriate distribution column.

**Payment by Notes, Drafts, etc.**—Payment of a voucher by a promissory note is recorded in the general journal:

Vouchers Payable	\$950	
Notes Payable		\$950

The liquidation column in the voucher register must be made to show:

- 1 Date of payment
- 2 Number of the note
- 3 Page number of journal where the entry occurs

At maturity of the note a new voucher must be drawn to liquidate. Notes Payable. Expressed in journal form, the entry is as follows:

Notes Payable	\$	
Vouchers Payable		\$

Thereafter the voucher follows the usual channels.

**Delayed Payments.**—When bills are not paid promptly each month unpaid vouchers may accumulate making it desirable to keep a creditors' ledger, thus modifying one advantage of the voucher system. Also more clerical time is consumed in referring to the voucher register sheets of previous months to indicate final payment of vouchers.

**MANUAL AND MECHANICAL TYPES OF VOUCHER SYSTEMS.**—The question of whether to use a manual or mechanical type of voucher routine depends entirely on the size of a concern, the number of transactions involved, the extent and complexity of the voucher distributions. Obviously small and medium-sized concerns do not need the elaborate installations of large concerns, and yet the former can get all the protection from simple installations that large outfits obtain from systems that are of necessity more involved. It is to be noted, however, that in theory there is no difference between manual and mechanical types. The end results always lead to the same summaries and postings to the control accounts and the subsidiary ledgers. The basic purposes of all types of installations are the same, namely, complete audit of purchases to guard against error and fraud, and the creation of documentary evidence in support of the voucher payments. The only difference between the manual and mechanical installations is one of pro-

cedure and the application in the latter case of mechanical aids to make possible the handling of a large volume of transactions

**SIMPLE TYPE VOUCHER SYSTEM**—A simple type of voucher system is described by Hartman (N A C A Bulletin, vol 23). The system does not require expensive posting machines, and shows a high degree of flexibility, particularly at times of peak loads when any number of operators may work on vouchers and distributions. The system is capable of handling 7,000 invoices a month without confusion and at a minimum cost.

The form of voucher register used is shown in Fig 19. It consists of ten perforated tickets to a page, each ticket is issued in triplicate. The original is for the accounts payable department and serves as a

NAME <u>O. K. Machine Company</u>						DUE	<u>1/10</u>
						DIRC	<u>25</u>
						NO	<u>123425-30</u>
MATERIAL		FREIGHT	CR.	CC NO.	DATE		
REQ.	QTY.					DEB.	
	140.25				16	140.25	
	175.00		12.50		17	162.50	
	(19.10)		1.90		17	(21.00)	
476.50		2.00	23.50		18	502.00	
(27.50)					20	(27.50)	
		875.00		1681	30	375.00	

Fig 19 Voucher Register Ticket

check request the duplicate is the unit distribution ticket for distributing the charges, the triplicate is not perforated and serves as a voucher register. The procedure is as follows:

**Entering Invoice**—The voucher register clerk arranges invoices alphabetically, numbers the invoices and enters the invoices on voucher register tickets. Each ticket accommodates six invoices from the same vendor. Fig 19 illustrates the method of recording the invoice. The first two columns are used for recording materials at standard cost. The third column is for freight and the fourth and fifth columns for debits and credits to other accounts. In recording invoices for materials these debit and credit columns are used for purchase variances and no account number is needed. Where the miscellaneous debit or credit is to some account other than a variance account the account number is recorded in the sixth column. This is illustrated by the debit of \$375 to account 1681. The final column on the exhibit is for recording credits to accounts payable. The handling of debit memos, which are the reverse of invoices, is also illustrated in Fig 19. The circling of amounts indicates a credit to the account charged and a debit to the vendor, as shown in the entries for \$19.10 and \$27.50.

**Auditing Invoice**—The following checking procedure is used in auditing invoices

- 1 All invoices are run off on an adding machine tape
- 2 Voucher register tickets are sorted by due dates and listed on a voucher payable control sheet (Fig. 20)
- 3 Separate tapes are run for each due date
- 4 Due date tapes are added. Invoices and due date tapes must agree.

DESCRIPTION	ACCOUNTS PAYABLE BALANCE	DUE 1/10	DUE 1/15	DUE 1/25	DUE 2/10
Per fwd.	\$10 000	\$5 000	\$2 000	\$2 000	\$1 000
120001 120250	10 000	8 000	2 500	4 000	1 500
Paid 1/10	7 900	(100)	2 500	4 000	1 500
Transfer Cr Bal	7 900		2 400	4 000	1 500
120251 120600	13 900		4 400	7 000	2 500
Paid 1/15	9 500			7 000	2 500

FIG. 20 Control Sheet for Voucher Payable Tickets

**Paying from Voucher Payable Tickets**—Voucher payable tickets serve as check requests. Invoices are filed alphabetically, tickets by due dates. The following payment routine is observed:

- 1 Tickets are sorted by vendors
- 2 Voucher checks are addressed and dated
- 3 Checks are run through a wide carriage adding machine with a date column attachment. On remittance memo attached to check invoice date and amount are listed.

After all the tickets for the one vendor have been run on adding machines, subtotals are taken, discount allowable is determined and the net amount is shown. The same procedure is followed for all checks, keeping the voucher payable tickets and checks together. With a numbering machine the check number is stamped on the voucher payable ticket. This cancels the voucher register ticket and means "paid in full."

**Proof of Checks**—The next step is to run a tape for each of the following:

- 1 Voucher payable tickets
- 2 Net amount of checks
- 3 Discount

The sum of tapes 2 and 3 must agree with the total of tape 1 and with the total due on that due date (Fig. 20). Next the checks are "protected" and a tape is run of the "protection." This tape must agree with tape 2, the net amount of the checks. This tape is sent along with the checks to the signing officers. Tapes 1, 2, and 3 are filed as working papers, with pay date and numerical sequence of checks paid noted on each tape.

One copy of the check is filed in the invoice file and another is filed in numerical sequence. The paid **voucher payable tickets** are filed numerically by check numbers in a 3" x 5" file.

**Proof of Open Accounts Payable**—To prove the open payables at the end of the month it is merely necessary to run a tape showing the voucher number and amount the voucher number being put in by utilizing the "non add" key. It is advisable to prove the voucher payable file after each major pay date or periodically whichever is most convenient.

**Unit Distribution Ticket**—Duplicate tickets are filed according to account numbers to be charged and posted to a distribution control sheet. Where more than one account charge appears on a ticket each extra charge is transferred to a new ticket and scratched on the old. Thus in Fig. 19 one additional ticket is made out to charge account 1681 for \$375.

When all distributions are completed, a journal entry is made debiting the distribution accounts and crediting Accounts Payable. The latter must agree with the amount turned over to the accounts payable section for the month.

The duplicate unperforated copy is bound and filed and constitutes the voucher register. Its chief purpose is for use by the auditors.

**MACHINE POSTED ACCOUNTS PAYABLE ROUTINE**—A simplified accounts payable routine is described by Collins (NACA Bulletin vol 23). This was developed as the result of an intensive methods study which revealed inefficiencies and errors in the old system. The latter handled about 2000 invoices a month involving 2300 subsidiary accounts. It called for the preparation of 1200 vouchers and 1,200 checks a month in addition to the customary records (Fig. 21).

ACCOUNTS PAYABLE REGISTER (Perforated Monthly)						
Date	Account Pay. No. Ref. #	Supplier	Debit Distribution Account—Amount	Credit Accounts Payable Control		
1/31/-	11271	Atlantic C. M. Co.	\$5.00	\$9.90		

ACCOUNTS PAYABLE VOUCHER AND DUPLICATE REMITTANCE ADVICE (Typed)						
Date	Check #	Cash	Supplier	Supplier	Amount	Net Amount
1/31/-	1944	A 166	174 N. Atlantic C. M. Co.	\$10		\$9.90

CASH PAYMENTS BANK AND CHECK (Bookkeeping Machine)						
Date	Check #	Cash	Supplier	Debit Accounts Payable Control	Credit Cash	
1/31/-	1944	A 166	All 100 So. St. Street N. York City	\$9.90	\$9.90	

SUMMARY OF DUPLICATIONS IN ABOVE FORMS (1 Serial & Number of Duplicate Entries)			
Date of Entry	Three Duplicates	Supplier Invoice	Amount of Invoice
3 days	5 times	3 times	5 times

Note—As given out under the old system as compared with 1 entries under the new accounts payable system.

FIG. 21 Basic Forms in Conventional Accounts Payable System (five forms)

The handling of suppliers' invoices was cumbersome and is summarized by Collins as follows:

Operation	Description	Building	Location
1	Mail room receives incoming suppliers invoices		1
2	Calculating machine operator checks computations	2	
3	Purchasing unit checks invoices with tally	2	
4	Accounts payable unit enters invoices with tally		3
5	Subsidiary ledger unit posts charges in ledgers		3
6	Cashier files invoices by payment date		3
7	Typist prepares accounts payable voucher	4	
8	Calculating machine operator adds voucher	4	
9	Bookkeeping machine operator prepares cash payment book and check	4	
10	Cashier checks completed accounts payable voucher		5
11	Auditor checks vouchers and invoices	6	
12	Assistant manager signs checks		7
13	Auditor mails checks	8	
14	Accounts payable unit files paid vouchers		9

Figures in above columns indicate change of location

Note: The above table indicates that each supplier's invoice was handled a minimum of fourteen different times by ten different employees. This involved a change of location nine times all in one building in which only three locations were used. The messenger boys called this the vicious cycle. It was:

A critical appraisal of the old system reveals the following shortcomings:

- 1 Too many different people were involved in the procedure
- 2 The same persons handled the invoices many times
- 3 The same data were recorded many times in different records
- 4 The invoices changed locations too many times
- 5 Payment of invoices on due dates created peak periods on the tenth, twenty-fifth and last days of the month in three different departments and disrupted normal operations on other work
- 6 Difficulty in balancing accounts existed because the records were prepared independently of one another

The revised system requires the payment of invoices when received or else holding the invoice for later payment without immediate recording of the liability. Interest lost by paying invoices ahead of the due date amounted to only \$30 a year but saved clerical expense of \$2,000 a year. The following six required records are made in one coordinated bookkeeping machine operation (Fig. 22):

- 1 Account distribution ticket (One ticket is prepared for each account in order to secure monthly general ledger control account totals)
- 2 Accounts payable register
- 3 Accounts payable voucher
- 4 Remittance advice to supplier
- 5 Check to supplier
- 6 Cash payments book

(All forms are prepared in an co-ordinated bookkeeping machine operation)

Line No.	Operation	Column (a)	Column (b)	Column (c) Reg. No. 1	Column (d) Reg. No. 2	Column (e)	Column (f) Reg. No. 2	Column (g) Reg. No. 3	Column (h) Reg. No. 4
		Reference	Account	Supplier	Amount	Debit	Credit	Debit	Credit
1	1st acct. d. m. t. l. t.	A1944	25-000	4.45					
2	2nd acct. d. m. t. l. t.	A1944	25-70	4.45					
3	Voucher (1st line)	A1944	174X		9.90				
4	3rd acct. d. m. t. l. t.	A1944	25-70	00.00					
5	Voucher (2nd line)	A1944	174Y		00.00				
6	Check				7.90				
7	Check								
8	Check								
	Sheet Totals			100.00				100.00	90.00 50.00

4C MONEY DISTRIBUTION TICKETS				
Reference	Account	Supplier	Amount	Debit
A1944	25-000	4.45		
A1944	25-70	4.45		
A1944	25-70	200.00		

ACCOUNTS PAYABLE VOUCHER AND RECEIPTANCE AMOUNT (Two Part Form)			
Line	Supplier	Amount	Debit
3 Voucher (1st line)	A1944 174X	9.90	
5 Voucher (2nd line)	A1944 174Y	200.00	
6 Check	Audited	7.90	
7 Check			
8 Check			

CHECK	
Check No. 1944 (Per p. 1)	
Date—Feb. 19, 1940 (Stamped)	
ATLANTIC CHEMICAL CO.	
100 SOUTH STREET	
NEW YORK CITY	7.90
Signed	

Columns a and b are typewriter keyboard operations. Column c is only one requiring key depressed amount. Column d is obtained from depressing balance key. Column e represents typewriter keyboard operations. Column f g and h are all obtained semi-automatically like column d by depressing balance keys.

FIG. 22 Basic Forms Used Under Accounts Payable System  
(six records on four forms)

This system has been in successful operation since January 1, 1940 and with slight modifications is suitable for use by almost any company regardless of whether the volume is 100 or 50 000 invoices per month.

**Audit Procedure**—The revised audit procedure is as follows:

1. Supplier issues invoice.
2. Central purchasing department checks invoice for prices and terms and indicates the due date. (Due date is still indicated because some invoices are received too late for discount taking.)

3 Calculating machine operator checks invoice extensions totals and computes and deducts discounts

4 Local purchasing unit checks invoice with receiving tally inserts charge account and approves for payment (Up to this point there is no change from old system)

(Note The following steps are all confined to the same location in the building thus eliminating the eight changes existing in the old system. In addition 95% of the movement of papers has been confined to three adjacent rooms in which are located respectively the three employees handling the bulk of the work i.e., the bookkeeping machine operator the cashier and the auditor)

5 Accounts payable unit receives at 8 30 AM invoices approved for payment by the purchasing unit the previous day. Sorts invoices alphabetically by supplier by amount or previous month's expense. A 25 division horizontal sorting device is used. Lists amount of each invoice on an adding machine tape in duplicate in order to secure control total for the day's payment. The following three persons are advised of this control amount:

- a Bookkeeping machine operator in order that she may balance total of checks written for the day
- b Auditor in order that he may audit checks prepared
- c Cashier in order to meet the day's financial requirements

The accounts payable unit then sends the invoices to the bookkeeping machine operator

6 The bookkeeping machine operator receives the invoices daily at 9 15 AM and in one coordinated machine operation prepares six required records (four different forms) by one complete machine cycle.

**Machine Operations Procedure**—Fig 22 shows the basic records under the revised system and the method of their preparation. The illustration is one in which the payment involves a debit and a credit invoice. The debit invoice is charged to two different accounts and the credit invoice involves only one account. Collins states:

The most important point to observe in connection with the machine operation is that the amount charged to an account need only be inserted in the machine once by key depression. After that all other required amounts such as the total amount of the remittance advice the amount of the check the amount of the credit to the cash account and the amount of the debit to the accounts payable control are all obtained semi automatically by depressing various balance keys. This means that if the original amount is correct all five resulting amounts are also correct and they are correct on all records and copies of records produced simultaneously. Thus by means of a mechanical device which produces all records in one operation and which contains an amount accumulating register all of the difficulties of the old manual accounts payable system were eliminated.

**Monthly Summary**—At the end of the month three general journal entries are made by the accounts payable unit. These entries summarize the liabilities by months, and also show the liquidation of the accounts due.

(1)

General Ledger Control Accounts (per distribution tickets)	\$	
Accounts Payable		\$
To credit latter account for balance as of January 31 19—		

(2)

General Ledger Control Accounts

Accounts Payable

To credit latter for February totals

(3)

Accounts Payable

Cash

To summarize February disbursements

**Sorting Distribution Tickets**—At the end of each day the account distribution tickets are sorted in a 50-division horizontal sorting device by general ledger control account codes. Totals are obtained on adding machine tapes for each code for both the current month and the previous month. These totals are then posted on the bookkeeping machine to control account ledger cards. A machine proof sheet gives the total amount of daily postings, which must check with the total amount of cash payments for the day. At the end of the month these cards are used to prepare detailed accounting distributions for journal entries 1 and 2 outlined above. As the accounts payable register journal entry is closed on the fifth working day following the end of the calendar month all invoices received after that date are charged to the current month's expense in the accounts payable register.

**Cashier's Duties**—The cashier receives from the bookkeeping operator the suppliers' invoices, accounts payable vouchers and checks, and performs the following operations:

- 1 Dates checks with rubber stamp
- 2 Photostatic checks with machine
- 3 Compares check with voucher and signs check manually
- 4 Staples check to remittance advice (duplicate of accounts payable voucher)
- 5 Staples accounts payable voucher to supplier's invoice
- 6 Photostates accounts payable voucher and invoices with date of check by means of a perforating machine

**Auditor's Duties**—The auditor receives the following:

- 1 Accounts payable voucher stapled to the supplier's invoice, also the check stapled to the remittance advice
- 2 Advice from accounts payable unit on the total amount of invoices passed for the day
- 3 Cash payment book sheet from the bookkeeping operator

According to Collins

The auditor's duties consist of verifying the approvals on each invoice and computing the supplier's name and address on the invoices with that on the check. Several other items are checked. Most important of all he ascertains that the amount of the invoice as passed by the accounts payable unit per advice to him equals the amount of cash payments made for the day. An accounting is also made of the number of checks used. All accounts payable vouchers are signed by him as being audited and correct.

The completed checks and remittance advices are then sent to the mail room to be mailed in window envelopes.

The suppliers' invoices and attached accounts payable vouchers are then sent to the subsidiary ledger unit for manual posting in the detail expense and capital accounts.



**Distribution Ledger**—The subsidiary ledger unit posts the individual account distributions to the various ledger accounts, using the check number for a posting reference. The **accounts payable** unit then files the completed vouchers in folders alphabetically by suppliers. There is one folder for each supplier, and this file thus becomes a supplier index of paid invoices.

**Results of Revised System**—The figures below show in comparative form an indicated saving of approximately 50% in favor of the revised system as compared with the old.

		Hours Per Day		
		Old System	New System	Saving
1	Accounts Payable Unit			
	Entering invoices in acct pay register	3¼		} 4¼
	Balancing acct payable monthly	2		
	Preparing invoices for payment		½	
2	Calculating operator			
	Adding register and remittance advice	½		½
3	Cashier			
	Filing invoices by payment date	3¼		} 3
	Dating and signing checks etc	¾	1¼	
4	Typist			
	Typing remittance advice	1¼		1¼
5	Bookkeeping machine operator			
	Preparing check and cash payment bk (2 items)	3		} -2
	Preparing all six records		5	
6	Auditor			
	Auditing vouchers and checks	1½	2	-½
7	Executive			
	Signing checks (transferred to cashier)	½		½
8	Subsidiary ledger unit			
	Posting to detail accounts	6	5¼	¾
9	Messengers			
	Carry rush items	1	½	½
Total hours per day		23¾	14½	9¼

The above savings of over one employee were slightly offset by an additional stationery cost of about \$10 per month and an interest loss of about \$2.50 per month. If the time of the subsidiary ledger unit is eliminated from the above totals it will be seen that the new system reduced the time required by approximately 50%.



## SECTION 6

### SETTING STANDARD COSTS

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## SECTION 6

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### SETTING STANDARD COSTS

#### Standard Costs as Tool of Management

##### CHARACTERISTICS OF STANDARD COST ACCOUNTING

-Historical costs possess very distinct limitations when complete reliance is placed upon them to provide data which management needs to plan and control operations. The actual cost of a unit of product conveys by itself no information concerning the efficiency with which it was produced. On the other hand if the actual cost can be set beside a standard cost which represents a known level of accomplishment, it then is a simple matter to compare the two costs and grasp the significance of the actual cost figure.

Introduction of a standard cost is another step in the process of establishing complete control over all factors which are subject to the influence of management. Pioneers in the scientific management movement found that good physical standards (that is standards expressed in terms of pounds of material, hours of labor, etc.) were basic to real control over both the amount and the quality of work done in a shop. The general procedure was to determine by study and experiment

1. What constituted a proper level of performance.
2. The best method or most satisfactory design to be used as a model of excellence to which to conform and as a base from which to measure deviation from the preestablished goal.

However, maintenance of a desired production schedule is not in itself sufficient to protect profits. Instead this production schedule must be achieved at a proper cost. In other words, realization of profits requires not only technical efficiency, but economic efficiency as well. Therefore standards which serve as a basis for control of operations must represent not only physical quantities of materials and services, but costs of these services as well.

Frederick W. Taylor, Harrington Emerson and Henry L. Gantt among others directed attention to defects of industrial accounting and its failure to supply adequate control data. Emerson wrote as follows:

There are two radically different methods of ascertaining costs: the first method to ascertain them after the work is completed, the second method to ascertain them before the work is undertaken. The first method is the old one still used in most manufacturing and maintenance undertakings; the second method is the new one, beginning to be used in some very large

plants where its feasibility and practical value have already been demonstrated.

**DEFINITION OF STANDARD COSTS**—The term "standard costs" has been defined in many ways. Those aspects of standard costs upon which there is general agreement among accountants may be taken as a starting point.

1 Standard costs are **predetermined costs**. However, not all cost figures prepared in advance of operations are admitted to the category of standard costs. Standard costs are established by a process of scientific fact finding which utilizes both past experience and controlled experiment. Thus the process of setting standard costs generally includes

- a. A careful selection of materials
- b. Time and motion studies of operations
- c. An engineering study of equipment and other manufacturing facilities

On the other hand predetermined costs that represent merely some average of past experience or personal opinion not based upon a scientific assembly of facts are generally termed **estimated costs**.

2 Standard costs represent a **carefully planned method of making a product or rendering a service**.

A series of acceptable definitions follows:

**Standard** that which is established by authority as a rule for measuring, being or according with, a standard for comparison having a recognized value. (Webster's New Ideal Dictionary.)

**Cost standard** standard material, labor or burden cost of any item factor or operation set after careful analysis and established by authority as a rule for measuring and comparing.

**Standard cost** The cost of parts or of plant production determined by computation of manufacturing specifications of material labor and burden at cost standards.

**Standard cost method** An accounting plan which compares actual net profits with predicted net profits based on computation of the standard cost of production budgets of expense and budgets of sales volume with analysis of variations from predicted results by their causes.

**TYPES OF STANDARD COSTS**—Beyond the above point there is however a controversial field. The principal differences of opinion seem to arise over these questions:

- 1 Whether a standard should be a **current standard** which reflects what performance should be in the period for which the standard is to be used or a **basic standard** which is to serve merely as a standard of measurement or point of reference.
- 2 Whether the standard should be set at an **actually expected**, a **normal** or an **ideal level of accomplishment**.

**Current Standards**—A current standard is one which is intended to be representative of what a cost actually should be under prevailing circumstances. It is generally regarded as a real cost to be carried through the books of account and into the financial statements. Such standards must be revised frequently to reflect changes in methods and prices, for otherwise they cease to be representative of what costs actually should be under present circumstances.

**Basic Standards**—A basic standard is intended to serve only as a yardstick with which both expected and actual performance can be compared. While possessing some of the characteristics of standard weights and measures it is more nearly analogous to the base upon which a price index number is computed, for the plan of cost accounting used with this type of standard proceeds by reducing actual costs to percentage relatives with standard cost as a base. Unlike current standard costs basic standard costs are used along with actual costs in the ledgers and financial statements. One important characteristic of basic standards is that they facilitate showing of trends in current expected and current actual cost relative to the basic standard cost. Such calculations require that the base upon which ratios are computed shall remain fixed and hence basic standard costs are changed only when methods of manufacturing are altered.

**Relation of Basic to Current Standards**—When basic standards are applied, it is necessary to use current standards also, but current standards can be used without basic standards. The reason for this is that a basic standard by itself does not necessarily represent what the performance ought to be in given period but serves only as a base from which to measure changes. In order to realize the principal benefits from standards it is essential that standards be reasonably attainable goals. This is a condition which can be met only by changing standards to reflect changes in prices and other circumstances affecting costs actually realizable. Hence when a system of basic standard costs is used the following rules govern:

- 1 Current standards are determined and expressed as percentages of the corresponding basic standard figures.
- 2 Actual costs likewise expressed as percentages of the basic standard are then compared with the current standard to find out how much actual performance has deviated from what it should have been and with the basic standard to determine trends from period to period. This latter comparison would not, of course be possible by measuring changes from a shifting current standard.

### STANDARDS RELATED TO LEVEL OF OPERATIONS—

With respect to the level at which standards are set, three general classes of standard costs can be distinguished although one class merges into another in a manner that often defies clear cut placement of a specific set of standards. These various levels are

- 1 Expected actual costs
- 2 Normal capacity
- 3 Ideal standards

**Standards Based on Expected Actual Costs**—Standards of the first type are set at a level which represents the costs the business actually expects to incur if the anticipated prices are paid for materials and services and if usage of these elements corresponds to that believed necessary to produce the planned volume of goods. Such a standard does not eliminate all inefficiencies but allows for waste and error which the management believes to be impractical of elimination. Under this scheme, variances from standards represent deviations from

- 1 Expected degree of efficiency from usage of production factors
- 2 Predicted purchase prices of materials and services
- 3 Expected volume of production

Obviously these variances can be either debit or credit variances that is, they can reflect performance either worse or better than anticipated

**Standards Based on Normal Capacity**—Standards of the second type are set at a level regarded as "normal." Normal may be defined as a statistically determined figure intended to level the fluctuations from seasonal and cyclical causes and to eliminate erratic fluctuations. An other way of describing normal standard is to say that it is the average level actually expected to be attainable over a period of time long enough to cover one or more operating cycles. The exact meaning given to normal is generally difficult to ascertain in any given case a fact which doubtless reflects the equivocal nature of statistical techniques available for ascertaining what a normal level of business may be. Hence normal capacity is defined as

The number of standard productive hours which will produce at normal efficiency sufficient goods to meet the average sales demand during an extended term of years preferably a complete economic cycle

(See discussion on normal capacity later in this Section also in Section 20)

Variances under this system may be interpreted as deviations from

- 1 Normal efficiency
- 2 Normal dollar volume

**Ideal Standards**—The third level at which standards are set is one representing the best performance that can be attained under the most favorable circumstances possible. Such standards are not those which anyone expects to attain but rather are ideals set up to strive for in an attempt to improve efficiency. Here variances are always unfavorable and must be interpreted as failures to attain ideal level of efficiency. However it is not reasonable to hold employees responsible for the whole of such variances because they are in part the result of human imperfection and of working conditions that also deviated from perfection. However in the literature of cost accounting the terms "ideal" and "current" standards are sometimes used interchangeably.

**RELATIONSHIP BETWEEN BUDGETS AND STANDARD COSTS**—Both budgeted costs and standard costs are predetermined costs and represent in application of the same basic idea. Thus Mc Kinsey (N A C A Year Book, 1927) states

In the broadest sense all standards are budgets and all budgets are standards. When a standard is established you are in effect setting up a goal which you wish to reach or a measuring stick of your activities.

Harrison's writings of this period indicate the same trend of thought (N A C A Year Book 1928)

There is no basic difference between standard costs and budgets. They are both based upon the fundamental idea of predetermination as opposed to the old idea of reporting events after they have happened.

The principal difference lies in the scope of the terms for "budget" is a broader word than "standard cost." Budgeting comprises the setting



of objectives for all aspects of income and expense and for all functions of a business whereas standard costs include ordinarily only regular expenses of operation

**PURPOSE AND ADVANTAGES OF STANDARD COST METHODS**—Most standard cost plans are designed for the express purpose of fulfilling the following requirements

- 1 To aid in the standardization of products of methods, and of processes
- 2 To focus attention on variations from established standards of production cost and factory expense
- 3 To provide a means of analysis of variations by causes
- 4 To simplify costing procedure and thereby to lower the cost of operating the cost system
- 5 To provide information with greater promptness

Additional advantages are presented below

**Productive Hours and Plant Capacity**—With improvements in standard cost technique new advantages have become apparent. The setting of labor cost standards requires the setting of time and rate standards. This results in the recognition of the standard productive hour as the basic unit of labor cost comparison of dissimilar parts and processes. Having found this common unit of comparison it becomes possible to convert sales quotas into production budgets, and further to compute reliable plant capacities.

**Ratios and Trends**—In the case of basic standards the results provide a uniform base and a series of ratios. These ratios when used as index numbers of comparison, in the manner familiar in the comparison of commodity prices, stock market levels, etc., serve to indicate trends both as to direction and rapidity of change. Such ratios and trends may be determined for all cost elements.

**Stabilized vs Actual Costs**—The costing of inventories and of sales at standard cost with adjustment to actual cost through the application of ratios of variation resulted in true part costs rather than so called "actual" costs when determined by job order methods. Camman stated (N A C A Year Book, 1925)

standard costs are used only as a basis on which actual costs are computed and such actual costs may be made as "actual" as refinement can go. Not only so but the probabilities are that they will be more correct through less detail in calculation and certainly they will be more useful because they are expressed in relation to specifications for manufacture rather than merely in reflection to the happenings of manufacture.

Bass stated (N A C A Year Book, 1927)

what we used to call actual cost was far from representative of the true 'actual' of the item in question. What we called an actual cost was often the normal cost of manufacture plus such accidental congestion of abnormal costs as might exist in the shop department as a certain item was going through. These abnormal costs were not of a nature belonging to any specific item of manufacture but represented costs of mismanagement which should be evenly absorbed in cost of all items manufactured.

standard costs are much more truly the actual potential costs of manufacturing certain items than the old cost we used to build up through that time worn device known as the stock order cost plan.

**Idle Capacity**—Standard cost methods provide for determination of so called idle capacity expense. It is doubtful whether this information could be determined under any other method. Knapp (N.A.C.A. Year Book, 1924) stated:

Whether it may be possible to compute the cost of idle capacity for accounting use without using predetermined burden costs the writer doubts if it has ever been done.

**Distribution Standards**—Standard cost principles may be applied to the problems of sales and distribution. The technique developed on factory problems has been revised where necessary, and standard cost methods are extended in scope to include sales budgets, sales expense budgets and prediction of net profits. Modern standard cost methods focus attention on net profit variations and on cost variations.

**Plant Coordination**—Standard cost methods provide an additional advantage which is frequently overlooked. They are responsible for a good deal of the cooperative planning which is essential in the compilation of interlocking standards and budgets for every division, every department in fact, for every individual and function in the business organization.

**Summary of Advantages**—The advantages of standard costs in addition to those already listed may now be summarized as follows:

- 6 To provide a common unit of comparison of labor costs
- 7 To set normal plant capacities
- 8 To provide a uniform base of comparison for all cost elements
- 9 Determination of the rate and direction of cost trends
- 10 More accurate cost and simpler costing procedure in evaluating investments in inventories
- 11 Greater practical benefit to the sales division in furnishing more accurate and stable costs as a basis for establishing selling prices
- 12 To provide a basis for the determination of idle equipment or idle capacity expense, which can then be eliminated from current production cost
- 13 To provide objectives for all divisions of business
- 14 Net profits can be predicted and variations from the predicted results can be analyzed by causes
- 15 To assist sales and general executives to more effective control by concentrating on exceptions from standards
- 16 To promote cooperation and coordination of the efforts of all divisions of a business

## Direct Material Standards

**BASIC DATA**—Successful standard cost methods require standardization of product design, operating policies, production routines and clerical routines, as well as standardization of costs. Stevenson succinctly stated this thought (N.A.C.A. Year Book 1928) "You won't have a standard cost system until you have standards."

Certain basic data must be compiled before the actual setting of cost standards can be undertaken. Such compilations usually require the services of various technical staffs such as the design engineers, chemists, production engineers, time and motion study engineers in addition to those of the accounting department itself.

The engineering and production departments should record all pertinent facts with regard to the kind and quality of raw materials and "findings" to be carried in stock, the kind, quality, and quantity of raw materials to be used for specific parts, the method and sequence of processing, part description and quantity requirements in assemblies, assembly labor methods and routines, material specifications or bills of material for final assembly or erection, and erection labor instructions.

**STUDYING THE PRODUCT**—Before standard costs can be set definite knowledge concerning the product must be available. For a concern that makes only a narrowly limited line of products subject to little variation, this problem is virtually solved in advance, but for a producer of a wide and perhaps continually changing variety of goods items to be manufactured during the coming period should be listed and complete manufacturing specifications procured. When the plant works largely or wholly upon a product produced to customers' orders and when the same design may seldom be used a second time, it is still possible to classify the product into general types and to find ways in which the special orders are alike. Many parts and subassemblies used in these special jobs may be standard or interchangeable. However, where diversity is present in a very large measure, as in building construction the drawings and specifications for each order supply basic data and new standards must be set for each construction order received.

**MATERIAL KIND AND QUALITY SPECIFICATIONS**—The next step is the development of material kind and quality specifications. This is known as setting material usage standards and involves a determination of what is the best and most economical material to use for each purpose. If good material specifications are already available as there are in a great many plants today it is comparatively easy to convert these physical standards into standard costs. On the other hand if no scientific study of materials has ever been made a careful engineering investigation should be a preliminary step to setting satisfactory standard costs.

The question of raw materials must be gone into from all angles. Sources must be investigated, methods of purchasing must be considered and such matters as the most desirable quantities to purchase and stocks to carry must be carefully determined. Where variations in quality exist these must be measured and the most economical quality for the specific purpose must be decided upon. It does not always follow that the quality which is best from an absolute standpoint is most desirable for the particular case. The same sort of examination must be given to supplies. The utilization of both materials and supplies must be studied for the purpose of finding the most effective methods. Sizes, proportions, cuts and mixes must be given attention.

Even though the process of scientific fact finding may be lengthy and quite expensive as it is in a large plant making a diversified line of products, potential economies discovered from this work alone often return the costs of the program.

A machine tool plant was producing a standard machine which contained approximately 25 miscellaneous shafts in its various assemblies. Some were forged while others were made from steel shafting which varied from  $\frac{3}{8}$  to 1 inch in diameter. Machining was intricate with varying diam-

cials to suit ten or more bearing diameters and gear or sprocket hub sizes. Complete redesigning of this machine resulted in adoption of a single size of shafting, namely  $\frac{1}{2}$  inch diameter. It was found that old shafts of more than  $\frac{1}{2}$  inch diameter were largely thus required for sound engineering practice and that smaller shafts could be increased in size with no deleterious effect in machine operation. All gear and sprocket hubs were standardized at slightly under  $\frac{1}{2}$  inch bore. All bearings were standardized at the same inside diameter. This standardization made it possible for this concern to use straight, uniform diameter shafts throughout the entire machine. Intricate and costly lathe and grinder operations were replaced by cheap machining of all shafts on centerless grinders. Machine and equipment requirements were materially reduced. Number of kinds and sizes of raw materials needed for production of shafts and bearings was reduced by more than 75% and investment in raw materials was reduced accordingly. This illustrates a portion of savings which resulted from redesigning of this machine. Similar standardization and economies were effected throughout. As a result the selling price of machines was reduced by more than 60% and potential market more than trebled.

While such standardization of raw materials is not essential to operation of standard cost methods, it frequently results as a natural and unpremeditated by-product of analysis of specifications and standardization of records in preparing for installation of such plans.

Raw material inventories can be materially reduced if the engineering department prepares standard material lists which can be used by designers in development of new parts and products. Additions to such lists should be prohibited unless approved by the chief engineer. Examples of such lists are shown in Fig. 1.

An analysis of sizes and kinds of raw materials carried in stock by most concerns usually discloses many items which could readily be eliminated by substituting other materials which are standard. Such elimination should greatly reduce the number of items carried as well as the amount invested in such raw materials.

Another class of inventory which frequently is found to be unnecessarily large is that of so-called findings and standard hardware. A metal manufacturing plant uses such items as machine bolts, cap screws, punched washers, cotter pins, taper pins, and many other similar items. Clothing and other allied industries use thread, buttons, binding tape, etc. Most industries have some similar class of inventory materials. If inventories have been built up with little attention to this subject, engineering department should be required to standardize on a limited number of types and sizes while all little used types and sizes are eliminated. Standard items should then be tabulated or charted for use of designers, the factory and accounting department. A chart of this kind is illustrated in Fig. 2.

Figs. 1 and 2 serve double purpose of aiding in standardization and simplification of inventories and as a guide and specification for accountant in setting standards for such materials and parts.

**MATERIAL QUANTITY SPECIFICATIONS**—These take the form of standard usage specifications, showing standard quantities to be consumed in each manufacturing operation. For an industry where processes are simple, these usage specifications are merely a list of things used per unit of finished product turned out. Where the manufacturing process is more complex and involves manufacturing of parts and then

STANDARD RAW MATERIALS		
Note: All items listed are carried in stock and purchased in sufficient quantity to obtain mill prices.		
ITEM <u>Brass Sheets</u> 80/20		
CLASS OR SYMBOL	DIMENSIONS	UNIT
B1	22 Gs x 6 x 60	Lbs
	22 Gs x 18 x 60	
	22 Gs x 18 x 72	
	20 Gs x 3 x 72	
	20 Gs x 8 x 60	
	1/8 x 3 x 60	
	1/8 x 4 x 60	
	1/8 x 17 x 60	
	1/8 x 19 x 60	
A		

STANDARD RAW MATERIALS		
Note: All items listed are carried in stock and purchased in sufficient quantity to obtain mill prices.		
ITEM <u>Armco gal Iron Sheets Blue Annealed</u>		
CLASS OR SYMBOL	DIMENSIONS	WEIGHT PER SHEET UNIT
1414	#10 - 36 x 120	1687 Lbs
	48 x 120	228
	60 x 120	2813
1415	#12 36 x 120	1313 "
	48 x 156	2215
1416	#16 36 x 96	60
	36 x 120	75
	48 x 120	100
	60 x 156	1625
B		

STANDARD RAW MATERIALS		
Note: All items listed are carried in stock and purchased in sufficient quantity to obtain maximum quantity differentials.		
ITEM <u>Burlap</u>		
CLASS OR SYMBOL	DIMENSIONS	UNIT
B1	12 oz - 36	Yds
B2	10 x 36	
	10 oz - 40	
B3	8 oz - 36	
	8 oz 40	
B4	7 1/2 oz - 40	
C		

FIG 1 Standard Raw Materials Lists

<p>T = Threads per inch</p>													
A	1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1			
B	7/16	1/2	5/8	5/8	3/4	13/16	7/8	1	1 1/8	1 1/4			
C	1/2	3/4	2 1/32	2 7/32	7/8	15/16	1 1/4	1 5/32	1 9/32	1 3/8			
T	20	18	16	14	12	12	11	10	9	8			
L D	1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1			E
1/8	S11	S19											3/4
5/8	S12												1/2
3/4	S13	S110	S117	S125									9/16
7/8	S14	S111	S118			S136							5/8
1	S15	S112	S119	S126	S130		S140						3/2
1 1/4					S132	S137	S141						1 5/8
1 1/2	S16	S113	S120	S127	S132	S138	S142	S148					1 1/8
1 3/4		S114	S121				S143						1 5/8
2	S17	S115	S122	S128	S133	S139	S144		S151				1 1/2
2 1/4								S149					1 3/4
2 1/2	S18	S116	S123	S129	S134		S145						1 3/4
2 3/4													2 1/4
3			S124		S135		S146	S150	S152	S153			2 1/4
3 1/4													2 3/8
3 1/2							S147						2 3/8
3 3/4													2 3/8
4													3
4 1/4													3
4 1/2													3
4 3/4													3
5													3
STANDARD PARTS													
Name USS Hex Hd Cap Screws										Key Symbol "S1"			

FIG 2 Standard Parts Chart

assembly later, perhaps in several stages, the principle is the same but specifications are more complicated. Here it is desirable to have a separate set of usage specifications for each stage in the process beginning with a standard list for each part, other lists for each subassembly, and finally still other lists for each final assembly.

Following is an illustration of **material standard setting for a silver plating operation** described by Redmond (N. I. C. A. Bulletin vol 15).

The weight of metal to be deposited on an article is best determined by measuring the surface area and thickness of coat, calculating the cubic content of metal in the finish and determining the equivalent weight by means of tables showing the weight per unit of volume (conveniently accessible in a handbook of chemistry). A metal surface one foot square is to be silver plated at a thickness of .0005 inch. The volume of silver required is .072 cubic inch (.144 square inches  $\times$  .0005 inch). The weight of silver is .007 ounces per cubic inch which furnishes the factor for conversion of volume to weight. The weight of .072 cubic inch of silver is then .437 ounce (.072  $\times$  .007 ounces). Occasional observation must be made to establish a standard allowance for wastage which will be assumed to be 2% (waste of silver being lower than for the cheaper metals). Applying this factor to the weight determined above the standard quantity of silver will be .446 ounce (.437  $\times$  1.02). Multiplying by the standard price of silver assumed to be \$35 per ounce the cost of the finish will be \$158. Computations may be simplified by calculating the **standard cost of a unit area at a specified thickness**, and connecting it into the cost of the product according to the proportions obtaining between the area and thickness of the coated unit and the area and thickness of the cost applied to the product. The formula for converting the cost in the illustration for example will be

$$\text{Metal Cost (cost of 1 square foot .0005 thick)} = \frac{\text{Surface area of product (in square feet)} \times \frac{\text{Thickness}}{.0005}}{.0005} \times \$158$$

**DRAWINGS**—Raw materials such as sheets, rods, bars, shafting and standard shapes of steel, brass, copper, nickel, aluminum and other metals, lumber, cotton, wool, rayon, burlap, and silk fabrics, and other similar standard materials, of all kinds, can be adequately described on records such as illustrated in Fig. 1. **Purchased fabricated parts** which are standard in design and can be purchased in the open market if available in various sizes can be satisfactorily described on standard parts charts as illustrated in Fig. 2.

Most manufacturing concerns, however, produce many fabricated parts from standard raw materials or from special castings and forgings made from dies and patterns of their own design. All special parts of this nature should be fully illustrated on drawings produced by the engineering department. Such drawings should leave nothing to the imagination of the workmen and should show not only finished dimensions, but also a complete description of raw material from which parts are to be made. The engineer who designs a part should know the kind, quality, size and amount of material which will be used so that he may bear full responsibility for the most economical use of materials. **Standard raw materials lists** (Fig. 1) should be referred to in determination of raw materials to be used to avoid addition of new items to inventories if a satisfactory size of material is already carried.

Fig. 3 illustrates the type of drawings described above. This drawing provides a description of the part, states part number or symbol used





for identification, specifies kind of material to be used, and specifies all labor operations necessary to convert raw material to finished part. This company supplements its technical blueprints with route sheets as illustrated in Fig. 4. These **route sheets** serve the dual purpose of setting up a permanent record of required processing, together with a record of tools needed and also, when job number and quantity have been inserted they are used as **production orders**.

If the blanking operation is performed by hand or with tools which allow some latitude in spacing of blanks, it is frequently found desirable to add layout data to drawings which will assure the most economical size of material and a minimum of scrap and trimming waste. Fig. 5 illustrates a layout drawing used in connection with an odd-shaped part which requires special layout instructions. A careful analysis shows that the layout illustrated will result in a clipping loss of 90 pounds per 100 pieces produced, which is 59% of the gross metal required. If 19 inch wide brass were used with blanks staggered and at a slight angle in a vertical position instead of the horizontal position shown in Fig. 5 the clipping loss could be reduced to 58 pounds per 100 pieces produced which is only 49% of the gross weight required.

An analysis of net cost per 100 blanks using several possible sizes

Sheet Size	Weight per Sheet	Pieces Pro- duced	Pieces per Pound	Cost per Blank	Per Cent Scrap	Set up Value	Net Cost per Piece
3 1/2 x 60	8.02	3	19	5033	76	1632	3401
4 x 60	9.17	6	19	2907	59	9720	2187
6 x 60	13.75	6	19	4351	72	1328	3021
17 x 60	38.90	25	24	3744	60	9741	1609
19 x 60	43.55	36	26	3146	48	9464	2682

A workman or foreman who does not and need not know the cost of raw materials would probably select 19 inch stock as most suitable to use which would result in a cost increase of 23% over the minimum cost obtained where 4 inch stock is used as suggested in Fig. 5.

**STANDARD METAL MIXTURES**—Most foundries produce a variety of castings and frequently several different analyses of metal are required. Determination of metal mixtures usually falls to the lot of the foundry superintendent, if he is a chemist or metallurgist or to the chemical engineering department where the volume of work is sufficient to justify such a department. Analyses of metal requirements as illustrated in Fig. 6 should be compiled and furnished to accounting department.

The illustration in Fig. 6 is of grey iron and semi-steel mixtures. Similar analyses should be prepared for mixtures of brass, bronze, aluminum, steel, and other metals and alloys.

**ASSEMBLY SPECIFICATIONS AND BILLS OF MATERIAL**—Assembled products require further engineering data in the form of specifications or bills of material. The form of such specifications may vary widely to meet the needs of each individual case. If products are of exceeding complexity it is usually advisable to divide the finished product into its sub-assemblies and part groups with separate specifications for each assembly or group. This method has an advantage

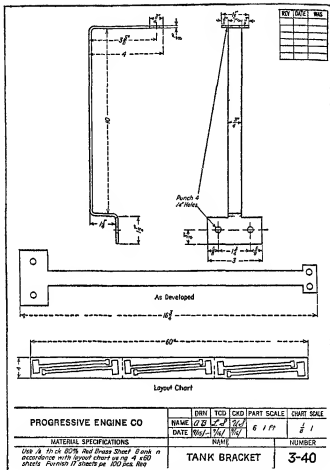


FIG 5 Drawing and Standard Layout Chart

in plants which manufacture a great number of models of the same article with a single, or a few, basic assemblies, such as chassis of an automobile, with many accessories or special parts which are interchangeable in the production of different models.

In the manufacture of musical instruments, manufacturers usually complete their product only to a semifinished stage. These instruments are carried in stock in semifinished condition in sufficient quantities for normal requirements of one or more months. Brass instruments may be finished by polishing, burnishing, engraving, silver plating, etching gold plating, and in various other ways to meet the demands of customers.

STANDARD FOUNDRY MIXTURES			
METAL USED	STANDARD QUANTITIES—PER CHARGE		
	MIXTURE No 1	MIXTURE No 2	MIXTURE No 3
PIG IRON — ZENITH	240	100	260
MAYARI			80
SPECF S	10		
TOTAL PIG IRON	250	100	340
SCRAP FOREIGN & I	390	700	
STEEL			80
MALLEABLE			160
REMELT	160		220
TOTAL SCRAP	550	700	460
TOTAL METAL USED	800	800	800

FIG 6 Foundry Mixture Standards

Material and labor entering into semifinished instrument, however is the same regardless of the type of finish which is later applied.

One company, manufacturers of gasoline engines, produces a limited number of sizes and types of engines. Each size and type can be built up to a "stripped" stage for general stock. Stripped engines are in themselves, built up of subassemblies and parts groups. Customers' orders which call for equipped engines are made up by assembling accessories and fittings to the "stripped" engines. This method of manufacture reduces the required investment in inventories without sacrificing speed in filling customers' orders.

Two forms of specification are used by the same company. The first of these is known as a specification analysis and is used in listing parts used in subassemblies and part groups. Part groups are two or more

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

duction orders

When the e forms are used as **production orders**, the planning department assigns an order number which is entered in the lower right-hand corner in the space provided. It should be noted that the column entitled "No. Per Unit" is followed by a column with blank heading. The upper space is used to record the date of the order. Immediately below is inserted the number of assemblies to be made on the order. In the column below are shown the number of pieces of each part which should be delivered by the stock department to the assembly department. The title column entitled "Material Origin" is for the information of stock department and perpetual inventory clerks, and indicates whether each item is to be raw material delivered from stores, manufactured stock from finished parts stock, or whether it is standard hardware or fittings carried in departmental floor stock and therefore requiring no requisition or delivery for specific order. This form eliminates writing of requisitions in drawing needed parts from stock and meets the requirements of material control through authorizing only sufficient part disbursements to complete a production order. If material shortages occur through breakage or waste this excess is immediately recorded as no additional material can be obtained except through use of special requisitions which must show the reason for stock deficiency.

After subassembly and parts group data have been compiled on specification analysis records, complete product assemblies can be described on standard specification index sheets (Fig. 8). In the example shown a complete engine assembly is made up of a stripped engine (AU69-11) plus 9 subassemblies, 9 parts groups, and 3 parts. In this way a complete gasoline engine containing a total of approximately 1,000 parts is completely described and identified as against any other engine which may be built.

Similar analyses can be prepared for any other assembled product. The more complex the assembly and the greater the number of parts used, the greater is the need for such grouping of parts and assemblies for simplicity of description, of production and of costing.

**SHRINKAGE, SCRAP, AND WASTE**—An important factor to consider in setting material usage standards is that of shrinkage, scrap, and waste. Many materials are subject to shrinkage or unavoidable deterioration while in storage or in the process of being worked upon.



Thus a certain loss in yardage occurs from shrinkage when dyeing cloth and a loss of weight takes place in the curing of meats. Other types of manufacturing result in the production of scrap as in punching discs from sheet metal. A third source of loss is wastage of materials which have been spoiled or rendered defective by inaccurate or careless work. While flowing from somewhat different causes all of these are responsible for losses of material put into process.

The first step is to determine whether such material loss is an inevitable accompaniment of the process, or whether it is due to avoidable carelessness and faulty methods. Since standards are supposed to represent what should be accomplished, any unavoidable loss of materials is logically considered in setting the standard, but material loss from avoidable causes should show up as an unfavorable variation from standard cost. Hence the setting of the material usage standard requires determination of

1. Minimum scrap loss—that is the method at which the material loss is at a minimum.
2. Amount of loss which should be incorporated in the standard as unavoidable.

**Minimum Scrap Loss**—The determination of the best method is primarily a matter of comparing optional ways for achieving the same result. These must be in terms of cost, for otherwise the economic significance of an alternative cannot be judged. Even the best method that can be found does not eliminate production of some scrap or the unrecoverable loss of some materials. Hence, material usage standards must be increased by the amount of this waste. When loss takes place while materials are in stores (from leakage, evaporation, deterioration, etc.) the price at which materials are charged out to material in process may be raised enough to cover the amount of the loss or an expense account may be charged. On the other hand, losses occurring while material is in process must be compensated for by increasing usage standard. Thus one company according to Spitznagel, allows for shrinkage of materials in the following manner (N. A. C. A. Bulletin, vol. 20):

In the manufacture of beer there is a certain shrinkage between the brewing of the liquor and the fermented liquor running anywhere from 5% to 10% which must be accounted for in the finished product. It is therefore necessary to include in the standard cost of a barrel of beer an amount to cover the cost of this shrinkage.

In the setting of standard costs the amount of this loss can be accurately predetermined and included in the standard material cost. To produce a finished barrel of beer with material value of \$1.90 we must put into process \$2.00 worth of material. To the figure of \$3.40 (including labor and expense of \$1.50), we add 10 cents giving us a total standard cost of \$3.50 per barrel.

**Unavoidable Material Loss**—Determination of the amount of loss which comes from unavoidable inaccuracy on the part of men and machines is a more difficult matter, for here it becomes necessary to draw a dividing line between that which cannot be avoided with even the best of care and that which represents carelessness, inattention and unnecessarily faulty work. Some material wastage inevitably occurs from the inherent lack of absolute perfection in both men and machines.

STANDARD SPECIFICATION INDEX SHEET	
MODEL <u>2C Engine Assembly</u>	SPEC No <u>A4750-37</u>
FOR <u>H R Stairs Inc</u>	ORDER No <u>C-1750</u>

X - Included in A069-11 Engine Assembly

9 10

FIG 8 Standard Specification Index Sheet

and the standard usage allowed should include something for this but all waste from other causes should appear in material usage variances.

**Level at Which to Set Standard Waste and Scrap Material Usage**—The level at which a standard is actually set is determined in large measure by the type of standard in use. If a standard represents what is actually expected, the allowable waste is determined by a forecast of the results of operations, if the standard is a "normal" one the average amount of waste experienced under similar working conditions should be taken, if an ideal standard is set, the level is put at the very least that is believed possible. In general, the setting of standards requires an examination of past results with perhaps an averaging of figures to obtain the most probable value for a waste allowance and perhaps also experimentation under controlled conditions or with specially selected operators. The experimental method is desirable if changes in methods have been made, for old data are not comparable with what is attainable under changed conditions. In many cases, however, standards for new products can be built up synthetically by using recorded experience for operations that are similar to those performed before making allowances if necessary for any differences that may have been introduced. These standards may later be revised when actual experience has been accumulated.

While this ordinarily requires considerable study by competent technicians it is sometimes desirable to begin at once with the use of standard costs and not to wait for careful material usage studies to be made because rapid changing of product specifications do not make refined methods worth while or because management wishes to realize some of the advantages of the standard cost method as quickly as possible. In this event standards based upon past experience and estimates may be put into effect and then revised as more accurate knowledge is gathered. Naturally the degree of crudeness existing in the standards must be kept in view when interpreting variances.

**RECORD OF EXCESS MATERIAL USAGE**—Adequate records of excess material withdrawals spoiled work and scrap production must be kept in order that cost variances may be explained and traced to their sources. These records should always name the person responsible in the organization. Various methods have been worked out for giving emphasis to the element of loss involved while preparing the basic record for accounting purposes. For example when material in excess of the standard quantity allowed is withdrawn, a so called excess material requisition may be required. This immediately brings to the attention of the foreman the fact that his production center is incurring an unfavorable cost variation and may stimulate him to seek a way to save material.

When adequate material usage standards are in effect, control over material losses, wastes and spoilages is facilitated because any variance from what has been determined to be a proper figure can be traced to its source. If it is due to faulty equipment, this can be repaired, if due to careless or improper use, pressure can be brought to bear upon the person responsible, or if due to causes over which the company lacks control (such as inability to obtain the proper grade of materials or the lack of skilled workers) the amount of loss from such conditions is at least pointed out in clear fashion.



**RAW MATERIAL HANDLING STANDARDS**—The question concerning what charges are added to the invoice cost of raw material (transportation inward, storage, receiving, purchasing, expenses, and similar items) can be handled according to the preference or custom of the concern using the cost system. It is desirable to set standards for these costs regardless of whether they are to be included in raw material inventory or to be charged to overhead. If the former practice is followed, standard costs for these items should be expressed as a certain sum per unit of each kind of material. When added to the invoice cost, the standard unit cost of material then results.

**MATERIAL PRICE STANDARDS**—Setting of material price standards calls for fixing a standard unit cost for each kind of material used. The result is a list or catalog of standard material prices. Fixing the standard material specifications depends on the nature of the standard to be used. If the standard calls for expected actual prices, the problem of standard setting is one of forecasting what the market prices of each of the needed materials will be. Many concerns contract for their materials considerably in advance of the time when they are to be used, and the contract price becomes standard material cost. In other cases it is customary to carry very large stocks of raw materials and here the price actually paid is available as the standard cost.

If the standard calls for **normal costs**, the process of setting standard prices requires a statistical determination of the normal price level. The procedure may be simply an **averaging of prices** paid for a period of years, perhaps eliminating periods affected by wars, extreme depression, and other extraordinary circumstances, or it may be more elaborate, taking into account trends and seeking to level out cyclical influences. The setting of price standards involves an element of individual judgment for the best price forecasting or best normal prices that current techniques can produce have proved to have a wide margin of error. This fact does not vitiate standards, however, for they still can serve as a check upon efforts of the purchasing department and as a readily available estimate of excess material prices.

The principle upon which **ideal standards** are constructed necessitates setting price standards at a figure below that at which it is expected purchases can actually be made. While this may serve to some extent as an incentive to the purchasing department, the market price of materials is often little subject to influence by an individual buyer and hence this plan of setting standards does not serve any useful purpose. There is also the disadvantage that, since inventories are often valued at standard, use of an ideal price standard leads to a lower inventory valuation. This may penalize the company because of the effect the lowered profit and the lower current ratio will have upon its credit standing. Hence, even though the ideal standard may be used for other purposes, it seems preferable to use an expected actual or normal price standard.

The level at which price standards are set under the basic type of standard is not important so long as price is not too far from reality. Prices current at the time the standard is set or prices which are thought to represent normal conditions may be taken for the purpose. The material element in inventories is priced at actual cost by the plan of

bookkeeping used with basic standards and hence no question as to involvement of the effect the standard price will have on the balance sheet.

**MAINTENANCE OF PHYSICAL CONTROL OVER MATERIALS**—Establishment of a standard cost system presupposes the existence of adequate physical control over the processes of procuring, storing, issuing, and handling of materials from the time a request to purchase is initiated until the finished goods are shipped to a customer. This control comprehends

- 1 Accurate budgeting of material needs
- 2 A proper purchasing routine
- 3 Supervision of incoming shipments and deliveries by a capable traffic expert
- 4 Facilities for receiving and storing incoming materials
- 5 Control of materials issued from stores by use of properly authorized requisitions
- 6 A method for identifying and controlling the location of materials in process
- 7 Proper storage and shipment of finished goods

Without systematic and careful handling of all of these activities, it is not possible to obtain sufficiently dependable cost reports to justify their collection and summarization for it is plain that managerial control cannot be exercised over buying and using materials unless the executives responsible have definite and accurate information about what is being done.

### Direct Labor Standards

**STANDARDIZING CONDITIONS OF WORK**—Setting direct labor cost standards is a process closely analogous to that employed for setting material cost standards but the techniques employed differ markedly since human operators are involved rather than inert substances. Pioneering the method for setting material standards the first step is selection of the best operating method available, in order that it may be used as a basis for the standards. This includes standardization of all surrounding conditions that in any way influence the effectiveness with which the worker performs his task.

- 1 Consideration of layout conditions of equipment, the work place and transportation facilities to standardize these at the best practicable level under existing circumstances
- 2 Establishment of control over materials in order that the workman may have correct quality and quantity available in the proper place. This requires investigation of purchasing, receiving and storeskeeping methods of plant transportation system and placing of materials at workbench or machine
- 3 Development of a system for planning, routing and dispatching of work
- 4 Provision of all needed instructions for the worker either in the form of advance training or directions for each specific job

Since standard costs are thus based upon methods and conditions which it is desired to attain variations of actual from standard then become indicative of real variations in efficiency relative to the standards. Lacking definite specification of what methods should be used and

what the surrounding working conditions should be it is hardly possible to locate the underlying cause for a variation and further it may also be impossible to determine whether the condition represents a desirable or undesirable state of affairs. As Tingley (N. A. C. A. Bulletin, vol. 8) has expressed it:

the setting of a real standard may depend upon the standards of your equipment and your materials. You must go back into your mills, rails and machinery before you can set any standards which your cost accountant can use over a month of time.

According to Martin (N. A. C. A. Bulletin, vol. 20)

Careful planning is an important key to the control of labor costs. When new devices are introduced into production the engineers, draftsmen, tool men, methods and wage rate men, inspectors and factory supervisors should discuss among themselves the design, tools and methods. Hand made samples should be assembled before tools are ordered. Tool made samples should be carefully tested before quantity production is begun. Such is good planning which will lead to lower planned labor cost and less extra cost.

This does not mean that ideal conditions are necessary, but only that there be established sufficient control over a worker's immediate environment to avoid introduction of uncertainty into the interpretation of standards and variances from standards.

**SETTING STANDARD OPERATION TIMES**—Establishment of standard operation time calls for determination of time needed to complete each operation when working under standard conditions. Many companies already have available complete operation time standards developed for purposes of wage payment and planning of production. These are exactly what is needed as a basis for the labor usage element in standard labor costs.

Where operation times are not already at hand, standard operation times should be set by one of the following methods:

1. Time and motion study
2. Average of past performance
3. Advance estimate

**Time and Motion Studies**—Time and motion studies furnish by far the most satisfactory direct labor time standards upon which to base standard labor costs. In fact it is the only method that can be depended upon to yield standards sufficiently reliable to permit other than a crude analysis of variations. Operation time standards set by averaging past performance or from estimates not based upon careful observation methods of time study work are always open to question when variations arise, since it is impossible to say to what extent the standard was wrong and to what extent there was a variance resulting from lack of efficient work.

Time study aims to analyze the manual and machine operations into distinguishable elemental motions and by making careful measurements of the time required to perform these when working under given conditions, time usage standards are set for operations to be performed. These labor time standards contain not only the time set as standard for performance of the operation but also allowances for rest for

necessary machine delays for set ups (if this is not to be considered a separate operation) and any other allowances regarded as essential.

**Average of Past Performance**—A second method is to take an average of past operation times shown on time cards. When a job order cost system has been in operation, actual time for direct labor operations is available and can be used as the source of data. If extreme figures are first eliminated (because they probably represent unusual conditions or mistakes) and the remaining ones averaged, this average of past experience serves as an actual expected time standard.

If changes in production methods have been made, the setting of standards must await the accumulation of new experience. Another unsatisfactory situation occurs where there is excessive variability in the operation time as a result of conditions over which workers have no control, for example, nonuniformity in material, machine failures, or working conditions that prevent concentration on the job. Such a situation can generally be recognized by the existence of a very wide dispersion in the past operation times or by inspection of the factory. Working conditions must first be standardized before a standard cost system can operate with any degree of satisfaction, for responsibility cannot be fixed or causes of variations traced when the sources of variations are too numerous.

**Advance Estimate**—Another method of determining operation time standard is to estimate it in advance. This method is particularly useful where an operation has not been performed before in exactly the same way, is not to be repeated, and represents an operation of considerable consequence. Thus construction of a building, ship, or a large special job of any other sort furnishes an occasion where this method of setting standards is useful. Quite often estimates are made first to establish a basis for bidding or quoting a price to the customer; after the order has been obtained these same estimates may be utilized as standards to facilitate the control of actual operations in order to make sure that the profit anticipated is realized.

Such estimates obviously must be based upon a thorough study of the situation and an assembly of all relevant data obtainable. This includes definite knowledge of what is to be done, comparison with past experience in similar operations, and inclusion of allowances for uncertainties. The magnitude of the latter item depends upon the type of standard, that is, whether it is to be actual, expected, normal, or ideal, although where same estimates are to serve as a basis for pricing, only actual expected standard can be used for direct material and labor costs.

In some circumstances it is feasible to develop empirical formulas, schedules, tables, or curves from which standards can be set for operations not previously performed. This is essentially the case with a flexible standard, for the formula represents a change in allowed operation time as some dimension of the production process is varied. Development of such a formula proceeds by analysis of the process to determine what elements are concerned, and then studying the way the operation time varies as the other elements are varied. This variation is expressed in the schedule, curve, or formula from which any value within the range of experience can be derived. The method is a familiar one to time study workers who call it **synthetic time setting**. It consists of analyzing classes of operations into those which are common

to all and those which are variable. This is explained by Barnes (Motion and Time Study)

When stop watch studies are begun on this work the elements should be selected in such a way as will make it possible eventually to construct tables of standard time data that may be applied to all elements that are likely to appear continually in that particular class of work.

The same authority also explains that with standard time data for the handling elements and time values for the machine elements, time standards are determined for a given operation without a stop watch study. An example follows.

Assume that tables are already available showing the details of time allowances for different classes of work for

- 1 Chucking and removing time
- 2 Machine manipulation time

The standard time allowance for drilling  $\frac{1}{4}$ -inch hole in the end of a shaft is then assembled as follows:

1 Chuck and remove piece (from totals on a prepared table)	50 min
2 Machine manipulation (from totals on a prepared table)	07
3 Drill $\frac{1}{4}$ inch hole (stop watch data)	54 "
Total base time per piece	<u>111</u> "
5% allowance	06 "
Total standard time per piece	<u>117</u> "

**SETTING LABOR RATE STANDARDS**—Since there is usually considerable variation in rates paid for labor, the first step should be establishment of a classification of labor grades used. This should comprise a definite set of specifications for each grade in order that grades may be clearly distinguishable. Among the characteristics upon which this classification is based are skill training, education, special physical abilities, experience, etc. The aim here is to set up a logical basis for differentials in wage rates paid, and to make possible specification of the particular grade of labor that is to be used for each operation in the plant.

The next step is setting of standard rates of pay for each of these grades of labor. Here, as above, the most satisfactory procedure is to base rates upon a scientific study of employee compensation. In this the procedure is influenced by circumstances under which labor is hired. If a plant operates under contract with a labor union, rates paid workers are fixed by the terms of the contract. In such a case the contract rates form the standard rates. If wages are established by bargaining individually with employees, the prevailing market rate for similar types of work is an important consideration, although it cannot be the sole guide. Most important perhaps is the establishment of a rate which fairly represents the qualifications of the job relative to other jobs in the plant.

If the standard is not to be set by so complete a study, the best approach is to use average rates paid in past periods, modifying these if necessary to bring them into accord with actual conditions anticipated. For this purpose, departmental payroll figures may be divided by the respective totals of hours represented to obtain average hourly rates, although in circumstances when a department uses several distinctly dif-

different classes of labor the departmental totals need to be broken down by classes of labor in order that a representative average rate of compensation may be obtained.

**OPERATION RECORDS**—Determination of proper methods and sequence of manufacturing processes is all too frequently made the responsibility of factory foremen who do not have a thorough training in engineering. A man who designs a part or product should know the best kind, size and shape of material to be used and should also decide what tools and equipment will be needed and the manner in which finished product can be produced most economically. The engineering department prepares supplementary blueprints covering rate and operation instructions as shown by route sheet (Fig. 4).

New or changed design of parts should never be adopted as standard without detailed study of available equipment such as machinery, jigs, fixtures and all necessary tooling. If such analysis is definitely recognized as a part of the engineering department's function then it must be conceded that preparation of operation records, as illustrated in Fig. 9, should also be duty of an engineer or at least that preparation of these records should come under his direction and subject to his approval.

A combination of operation record and piecework or premium rate record is desirable, as in the majority of cases departments using one portion of this record have equal need for the other portion and the combination has proved most economical to prepare and to maintain. Fig. 9 provides examples of such records prepared for use in the foundry in making castings, machine department in machining these castings and assembly or erection department in subassembling and in final assembly and testing of the finished product.

**EFFECT OF WAGE PAYMENT PLAN ON RATE STANDARDS**—The wage payment plan in use necessarily requires consideration when setting a labor cost standard, for different wage plans do not result in the same unit cost for labor. Three basic types of wage payment plans may here be distinguished, namely:

- 1 Day or hourly wage plan
- 2 Single piece rate
- 3 Multiple piece rates, bonus and premium plans

**Day or Hourly Wage Plan**—Here the standard labor rate is that hourly rate which represents the expected wage to be paid on the normal rate for a particular grade of labor to do the task to which the standard applies. If this rate is actually paid to all employees, no labor price variances appear, but if some employees are paid higher or lower rates, a labor price variance results.

When these different rates are paid as a matter of policy which recognizes such factors as length of service, versatility, experience and similar things, variances cannot be looked upon as the result of a deviation from expected or desired results and hence it becomes necessary to recognize these differences in the standard labor price. This can be accomplished quite easily by use of a weighted average hourly rate computed by weighting each different hourly rate by the number of men expected to be employed at that rate. By using this weighted average rate as a standard labor cost, the total standard labor cost will not



deviate from the actual cost by reason of the existence of those wage differences established as a matter of policy

**Single Piece Rates**—Under a simple piecework wage plan the standard labor cost of a unit of product is the piecework price regardless of the number of pieces made in a day by the worker. Any deviation from the standard labor rate per piece causes a price variance to appear. There is no labor usage or efficiency standard, nor any usage variances for work done on a piece rate plan. The piece rate is not changed without also revising the standard cost but frequently work is done on an hourly wage basis instead of piecework. Use of piece rate as the only standard can be defended on the ground that it represents a condition which it is desired to attain and that any debit variance arising because some work is done on an hourly wage represents a deviation from the desired level of efficiency. Yet at the same time there are few instances where all work can be paid for on a piecework basis. In fact a standard that assumes all operations to be on a piecework basis is virtually an unattainable ideal standard. Among reasons for such day work are provision of a fair wage for new employees, provision of a fair wage to employees working under nonstandard conditions or to care for a non routine operation on which no piece rate has been set.

Changes from piece rate to hourly wage result in labor price variances where standard costs are based on the piecework rate for efficiency is likely to be lower under a time wage than under a piecework plan of compensation. For this reason it is desirable to have a separate standard for work done on an hourly wage basis in order that such operations receive the benefits of standards for their control.

**Multiple Piece Rates, Bonus, and Premium Plans**—Where incentive wage systems of this character are in use labor cost per unit of output varies according to the rate of output and also according to the type of earnings curve that the wage plan yields. Thus direct labor cost per unit of output is, under multiple piece rate plans, constant within the limits to which each rate applies, but contains a "step" for each rate. Premium and bonus wage plans yield various direct labor cost curves as output is increased depending upon the nature of a particular compensation plan. Some provide a continuous unit cost curve which declines, others present a discontinuous cost curve and some widely used plans yield a labor cost curve which first declines and then continues parallel to the horizontal axis of chart. Multiple piece rates give unit labor costs which rise as output increases over a considerable range whereas the common bonus and premium plans give declining unit labor costs.

**LEVEL FOR LABOR RATE STANDARD**—There are two different practices here, namely:

1. To assume that 100% level of output is a reasonable one that ought to be attained and to set the standard at the wage rate paid for this degree of efficiency. When examining the resulting variance figures management must keep in mind that a debit balance in the labor rate variation account may be justified when it has resulted from a high level of output under a wage system that has been deliberately designed to yield an increasing unit labor cost with increases in worker output. It may also be noted that wage plans such as the Wennerlund Bonus



yield a constant unit labor cost at efficiencies over 100%, and hence there is no price variation when output is at or above the 100% level.

2 To assume that the standard labor rate should include the average bonus or premium earned. This method differs from the foregoing only in the level at which the standard is set. However in setting the standard it becomes necessary to study past performance records to ascertain what bonus is most commonly earned. If such records are lacking, the rate setter's expectations concerning what an average worker will earn under the plan may be adopted instead.

The choice between the above levels is best made according to the underlying policy upon which the wage payment plan has been constructed. Where the 100% level gives the rate of production and compensation which the average worker is expected to earn it is the preferable level at which to set the standard. On the other hand if the wage payment curve is constructed in such a fashion that the average worker is able to earn a bonus consistently, then the labor price standard should be set at this level.

Maintenance of control over labor cost requires an adequate and effective system for timekeeping and payroll handling. Without this data going into the accounts cannot be sufficiently reliable to be of value either as a guide to management or for determination of financial statement figures.

## Manufacturing Expense Standards

**DEFINITION OF MANUFACTURING EXPENSE**—Overhead or manufacturing expense consists of all charges other than those directly identified with the product. The latter include direct material, direct labor and such other charges as constitute specific costs of product units. On the other hand there is always a residue of costs that cannot be charged directly to product units and these fall in the overhead category.

Overhead is in reality, a composite of costs which behave very differently. Control of these costs and accurate costing of the product requires that overhead be broken down into elements that are reasonably homogeneous because where unlike costs are lumped together many essential facts are obscured. This classification must be effected before dependable standards can be set.

**DEPARTMENTALIZATION OF OVERHEAD**—The ultimate aim of overhead standards is to facilitate localization and control of expenses for purposes of cost control. The first step, therefore toward establishing standards for overhead costs is an analysis of expenses by operating divisions of the business. A primary breakdown is the separation of service departments from productive departments. Service department costs are assembled in order that they may then be distributed to the overhead accounts of productive departments which use the services. Unit cost rates for services are determined wherever possible in order that direct charges to consuming departments can be made. Within the productive departments it is advisable to classify

overhead by production centers if conditions within the department are not uniform. Thus separate cost center rates are needed to take care of products made with expensive machines on which overhead is high and other products going through the same department made with simple hand tools on which overhead is low.

### SEPARATION OF FIXED AND VARIABLE CHARGES—

The next step in the establishment of overhead standards is the separation of fixed and variable costs. Perfectly variable costs increase or decrease in proportion to the volume of work in the plant and hence they are controlled by keeping them within the limits set by current activity. Fixed costs do not change in total amount during a short period of time and hence they cannot be adjusted to current activity. Thus, when activity drops, variable costs should be curtailed sufficiently to prevent an increase in unit variable cost but since fixed costs cannot be reduced for a temporary drop in activity the unit fixed cost rises. Unless these two kinds of overhead are separated, it is impossible to determine whether an increase in unit cost is due to an unavoidable increase in unit fixed cost or to failure to control the total variable costs. It also becomes difficult to place responsibility for increases in costs when costs charged to a given department contain prorated fixed charges unless these fixed charges are clearly separated from the variable costs subject to control by department charged. Hence past experience of the organization covering a range of operating levels may be studied.

**Graphic Determination of Fixed and Variable Expenses—**A convenient technique for this purpose uses a simple chart in the following manner. Assume that it is desired to determine the fixed and variable components of supervision costs in a given department. The data given below are first obtained from records of past operations.

Period 1942	Activity in Direct Labor Hours	Total Supervision Cost	Period 1943	Activity in Direct Labor Hours	Total Supervision Cost
January	10 000	\$2 100	January	20 000	\$3 000
February	14 000	1 900	February	20 000	2 800
March	12 000	1 800	March	18 000	2 300
April	8 000	1 300	April	20 000	2 400
May	10 000	1 400	May	22 000	2 600
June	12 000	1 600	June	22 000	2 000
July	16 000	2 100	July	25 000	2 900
August	20 000	2 600	August	26 000	3 000
September	25 000	3 200	September	24 000	2 900
October	30 000	3 900	October	23 000	2 600
November	30 000	3 900	November	21 000	2 600
December	20 000	3 500	December	24 000	3 000

These figures are plotted in the form of a scatter chart as shown in Fig 10, the points being numbered in chronological order. A straight line of best fit is drawn through the points. This line may be sketched in by inspection or marked by stretching a string between pins. For a high degree of refinement a straight line may be fitted by using the method of least squares. This line sets the standard allowances at each rate of activity and may therefore be referred to as the budget line. In drawing the budget line which fixes standard expenditure for super-

points 8-15 have been disregarded because they represent excessive expenditures. In this way flexible budgets are made to depend not on mathematical formula but on judgment applied to a thorough knowledge of circumstances under which the budget is to be used. Nevertheless charts of the type illustrated are very effective tools of analysis for the standard setter. When this line is projected to the left until it crosses the vertical axis of the chart, an indicated fixed cost is obtained which might be expected if the plant were merely standing by ready to operate, but producing nothing.

Thus in Fig 10, the indicated stand-by cost is \$500 per period. If the total cost line rises as one moves to right on chart there is indicated a variable element in this total cost figure.

The amount of this variable cost at any given activity level can be determined by reading the distance between the fixed cost line and the total cost line, unit variable cost is the amount by which total cost rises with each unit increase in output. In Fig. 10, total supervision cost at the 20,000-hour activity level is \$2,500, subtracting \$500 fixed element leaves total variable costs of \$2,000, or a variable cost of \$10 per direct labor hour.

In this way, the budgeted or allowable expense at any rate of activity may be read from the chart directly or may be reduced to a formula. At 18,000 hours the chart (Fig 10) shows an expense of \$2,300. Using the formula indicated above, the expense allowed at 18,000 hours is

$$\begin{aligned} & \text{Fixed Charges} + (\text{Unit Variable Allowance} \times \text{D. L. Hrs}) \\ & \$500 + (\$10 \times 18,000) \\ & = \$500 + \$1,800 = \$2,300 \end{aligned}$$

A total cost line parallel to the horizontal axis of chart indicates that the cost is wholly fixed at all activity levels within the range charted, a total cost line which goes through the origin (i.e., where both coordinates are zero) indicates that the cost is wholly variable (Fig 11, curve 2). Should there be no tendency for points on a chart to be grouped along a line the chart indicates that no relationship exists between the measure of activity and the expense under consideration. Such a result suggests either that the unit in which the activity is measured may be a poor choice or that past control over cost has been very lax. In the first case, a different basis for the chart should be tried, e.g., machine hours may be used in place of labor hours, in the second case, past experience is of little or no value in setting standards.

If costs have not been closely controlled these historical figures probably include considerable inefficiency and hence further study is generally desirable before standard costs are set. Moreover, there may have been changes which should be reflected in future costs.

**Use of Chart in Cost Control**—Since the points on the chart (Fig 10) are numbered in chronological sequence the success with which variable costs have been controlled in past can be seen. Fig 10 shows that supervision cost has been rather closely controlled during the first seven months (points 1-7) when volume was low, with a substantial increase in production in next four months (points 8-11) costs were allowed to rise more than proportionately to output, and when volume again dropped (points 12-15) costs remained high. This is quite typical for where costs are not well controlled they tend to rise rapidly with

expanding output and then lag as volume decreases again. Apparently the management observed this, for the costs took a decided drop in the 16th month and then continued low during the remainder of the period covered.

Charts may be made for individual cost items, for each cost center for each department, or for the business as a whole according to amount of detail desired in standards. Charts of this type are illustrated by Martin (N A C A Bulletin vol 20) (Fig 11). They cover three types of expenses for indirect labor:

- 1 Service labor
- 2 Overtime
- 3 Tools and supplies labor

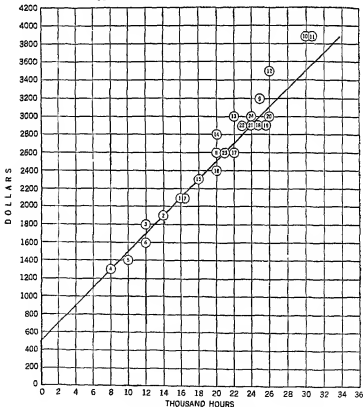


FIG 10 Determination of Fixed and Variable Components of Supervision Costs

The vertical axis shows the indirect labor expense expressed in hundreds of dollars per week. This is related to direct labor expressed in thousands of dollars per week on the horizontal axis. The resulting line of standard allowances is reduced in each case to a formula.

- 1 For service labor  
\$280 per week + \$002 per direct labor dollar
- 2 For overtime  
\$0211 per direct labor dollar
- 3 For tools etc.  
\$20 per week + \$0295 per direct labor dollar

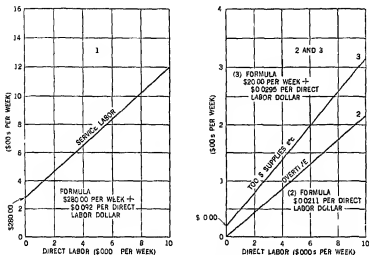


FIG. 11. Deriving Formula from Graphic Analysis of Fixed and Variable Components for Indirect Labor

There is no stand-by charge in the case of overtime since obviously overtime disappears at zero operation. To obtain the formula for service labor proceed as follows:

- |   |          |
|---|----------|
| 1 Stand by charge (zero operation)                  | \$ 280   |
| 2 Charge when direct labor is \$10 000 (from chart) | 1 200    |
| 3 Difference in service labor readings              | \$ 920   |
| 4 Difference in direct labor readings               | \$10 000 |
| 5 Ratio of item 3 to item 4                         |          |

$$\frac{\$920}{\$10\,000} = .092$$

or 9.2 cents per direct labor dollar

To find the allowed expense at for example, \$6 200 of direct labor proceed as follows

$$\$280 + (\$6\ 200 \times .092) = \$280 + \$570 = \$850$$

This checks with the graph in Fig 11

It is desirable to go beyond the chart and subject actual usage of overhead supplies, labor and services to an engineering study for the purpose of determining more accurately how much of each of these should be consumed. This point is emphasized by Martin (N.A.C.A. Bulletin, vol 20)

In arriving at the optimum indirect labor amount particularly for supervisory clerical or service labor each individual job should be considered and an affirmative answer arrived at for each of the four following questions

- 1 Is the job essential?
- 2 Is the job worth what we anticipate paying?
- 3 Is the right individual on it?
- 4 Is the method efficient?

The answer to the first question is a matter of judgment to the second a matter of salary or job evaluation to the third a matter of employee evaluation and to the fourth a matter of judgment based upon knowledge and conditions

**FLEXIBLE BUDGET**—The standard overhead expense may be represented as a schedule or curve or a formula which represents the way in which total usage should vary as activity fluctuates. Use of a curve or formula provides automatically the allowed expense at any activity level within the expressed range. If a schedule is used, it must set forth the allowable expense at specified points of activity. Such a schedule of standard or allowable expenses at various levels is called a flexible budget.

Fig. 12 shows a flexible budget for a shipping department. Note that both numbers of men to be employed and budgeted wage costs at each level are shown as a guide to the departmental executive in charge.

#### WAREHOUSING AND SHIPPING DEPARTMENT

Item	Activity									
	40%		60%		80%		100%		120%	
	Employees	Amount	Employees	Amount	Employees	Amount	Employees	Amount	Employees	Amount
Warehouse Foreman	1	\$ 250	1	\$ 250	1	\$ 250	1	\$ 250	1	\$ 250
Assistant Foreman					1	200	1	200	2	375
Warehouse Clerks	2	250	2	250	3	375	4	375	4	500
Warehouse Labor	4	500	4	600	5	700	5	800	6	900
Supplies		50		100		150		200		250
Totals	7	\$1 050	7	\$1 200	10	\$1 675	10	\$1 825	13	\$2 275

FIG 12 Monthly Flexible Budget

**NORMAL PLANT CAPACITY**—Normal capacity is defined in two ways

1 The **practical capacity** of a plant to produce, or what a plant could do if there were no lack of orders. This is less than the maximum physical capacity by the amount of **unavoidable idleness** for repairs, unforeseeable breakdown, shortages of material or labor, and other interruptions that are not humanly preventable. As stated by Richmond (N A C A Bulletin, vol 15)

Capacity (is) not a condition of excessive activity but the highest point at which the department can operate without increasing the strain on labor or productive facilities

2 The **average capacity** of a plant to produce and sell. This view of normal capacity allows both for unavoidable interruptions in a factory and for an average amount of idleness due to lack of sales orders. While it has often been said that average capacity should be approximately 80% of practical capacity, the exact level chosen depends upon experience of a specific plant. Thus James (N A C A Bulletin, vol 16) states

The General Electric Company's overall time analysis in its Erie Works when in full operation showed actual cutting time of only 23% for the average of all machines engaged in this work. Even on a conveyor under straight line mass production, 100% results are not attainable

**Overhead Absorption at Normal Capacity**—Normal capacity at any chosen level may be determined for one, two, or three-shift operation or for whatever length of working week the company expects to maintain. Experience indicates that either concept of normal operating level may be used depending upon the preference of those managing the business. As Schlatter (Advanced Cost Accounting) has pointed out, the choice of a rate is important, but it is much more important that the effect of the rate chosen be thoroughly understood. It should be realized that the **activity level** chosen is one at which 100% of the fixed overhead is absorbed by the product, and also that it is the level from which under- or overabsorbed activity variances are measured

**Practical vs Average Capacity**—Arguments for the use of practical capacity level are

- 1 With a practical capacity rate fixed costs of manufacturing facilities used are clearly separated from fixed costs associated with idle plant and organization
- 2 Inventories are valued conservatively for no costs of idle facilities are included in them
- 3 Real loss from lack of full utilization of equipment and organization is exposed instead of being partially or wholly buried in inventories and cost of sales

On the other hand, the following arguments are given by proponents of the **average capacity rate**

- 1 Average rate yields unit product costs which may be more useful for pricing because, over the long run, sales revenues must cover all expenditures including unused facilities if the business is to show a net profit
- 2 Most businesses possess sufficient equipment to meet peak demands and hence have some idle facilities most of the time. The profitability of a business depends upon being able to balance periods of

high and low activity. The average capacity rate here reflects the operating methods of a business and utilization variances serve as a measure of the success of management in keeping to desired average level of activity.

Following is an application of the average capacity rate as described by James (NACA Bulletin, vol 16)

Not in recent years has any manufacturer of egg cartons been able to procure orders enough to permit of operating his machines at their maximum capacity. One typical manufacturer equipped to produce more than 30 million boxes a year has actually sold between 15 and 20 million in each of the five years from 1928 to 1932 inclusive. It would seem wise for him to set his normal capacity at 15 million per annum, his peak demand at 20 million and to classify as "Excess plant expense" the fixed machine expenses attributable to all equipment in his shop beyond that required to produce 20 million.

Fig 13 shows the division of expenses devoted to the manufacture of egg cartons between operating and nonoperating expenses. The former will either be wholly absorbed in cost of product or go partly into "Volume Variance" when the plant is subnormally idle or supernormally busy.

The box machines are rated at 140 per minute each which would be at the rate of 672 000 a week. Deducting 20% to reduce output to average actual efficiency of 80% leaves 537 600 as maximum weekly capacity.

The required potential capacity of 20 million egg cartons per annum may be safely set at 400 000 a week—enough to meet the weekly demand for this type of egg cartons which is fairly uniform throughout the year.

A 400 000 potential capacity per week is only 74 4% of the present maximum physical capacity of 537 600. Therefore 25 6% of the allocated expenses of the box machines (\$76 24) should be classified as "Excess plant expense" namely \$19 52.

The allocated expenses of the filler machines of \$59 52 are likewise apportioned in part to "Excess plant expense" on the basis of their rated capacity of 50 per minute each.

**DETERMINING ALLOWABLE FIXED COST**—When the normal level of activity has been determined, fixed costs allowable at this level must then be set. Fixed costs are associated with providing manufacturing facilities in readiness for use regardless of whether or not they are being used at the moment. For this reason they are sometimes called stand-by costs. The amount of equipment and the size of the organization which is to be kept intact is a matter of managerial policy. The same is true of the amount to be spent for maintenance and repairs. Thus, in the final analysis, fixed costs are fixed only by managerial policy which is subject to change.

Generally it is desirable to study these indicated fixed cost figures closely before adopting standards. One approach is to discuss the figures with departmental executives to ascertain their opinion concerning the reasonableness of these figures to represent standard fixed charges. Another approach is to break down departmental fixed charges and examine each element separately for the purpose of determining what services materials and labor should be consumed during a period of temporary inaction. While most reliable standards are set by this detailed study, the time required may exceed that available for the purpose. Hence it may be applied only to the more important costs, the remaining standards being set by reliance upon past experience and managerial judgment.



Equipment	Maximum Capacity Per Week	Peak Demand Capacity Per Week	Excess Capacity Per Week
2 box machines— 1 shift 40 hrs per week at 80% operating efficiency	337 600 (100 0%)	400 000 (74 4%)	137 800 (25 6%)
7 filler machines— 1 shift 40 hrs per week at 80% operating efficiency	672 000 (100%)	400 000 (59 5%)	272 000 (40 5%)
Allocated Machine Expenses	Total Per Week	Operating Expenses	Excess Plant Expenses
2 box machines— Depreciation of machinery Depreciation of building Maintenance of machinery taxes and insurance	\$61 54 3 10 11 60 \$76 24 (100 0%)	[Detailed figures purposely omitted]	
7 filler machines— Depreciation of machinery Depreciation of building Maintenance of machinery taxes and insurance	\$47 30 2 00 9 62 \$58 92 (100 0%)	\$36 79 (74 4%) \$35 41 (59 9%) 9 13	\$19 42 (25 6%) \$4 11 (40 5%) 4 63
Total allocated machine expenses	\$135 76		

Fig 13 Settin Standard Machine Costs on Average Capacity Basis

## Responsibility for Setting Standard Costs

**ESTABLISHMENT OF PERSONAL AUTHORITY AND RESPONSIBILITY**—When costs are classified according to personal authority over spending, responsibility for each item can then be definitely assigned to a specific person, a standard can be established and that person held accountable for variances arising from any failure to meet the standard. Careful analysis to determine where authority over spending actually rests is necessary. Both primary and secondary authority must be determined for where foremen have primary authority to use supplies or power superintendents are also expected to see that the foremen under them keep their costs under control, and hence superintendents have secondary responsibility for seeing that standards are met. In general, authority and responsibility for cost control follow organization lines and an organization chart is a useful guide in classifying overhead costs.

**STANDARDS COMMITTEE**—The general direction and supervision of a standardization program is commonly delegated to a division or committee created for the purpose. Such a body continues in existence after the initial establishment of standards to aid in their effective application and to make changes that are necessary as new circumstances render previous standards obsolete. In a small organization the standards committee is usually a special committee of the regular executives which meets from time to time to discuss matters of general policy and to exchange ideas, while actual work of setting and enforcing standards is under direction of the various departmental executives. In a large concern there may be a standards division with a permanent staff of experts to do all the work of setting and adjusting standards.

Persons who are charged with the specific duty of setting usage standards must have sufficient technical knowledge to carry forward a program of research in the selection and usage of materials for standard setting is essentially a research problem. Ordinarily it is not satisfactory to allow factory foremen to select kinds and quantities of materials to be used, for notwithstanding the fact that these men are thoroughly familiar with processes and products, they are seldom acquainted with a sufficient range of materials, methods, and costs to set proper standards. Even the cost accountant sets standards only indirectly, his chief contribution is in the form of valuable information about the company's needs for cost data, type of standards and procedure likely to prove most useful, and the behavior of costs in previous periods.

Setting material price standards is a task best done by the purchasing department. If there are specialized buyers, their judgment is valuable in determining actual expected costs, but there may be a tendency to set prices high if the same men are later judged by standards they have set. Statistics concerning past purchase prices and current market quotations are also useful data that should be available from the files of the purchasing department. Thus Perry (NACA Bulletin vol 22) describes the practice of his company, the executive committee sets standard rates and prices.

At the first meeting of the executives there is presented for review and consideration the payroll rate manual which contains every labor rate being paid by the company. Any proposed changes are noted for the cost department. Also presented are detail schedules on all materials used showing stock on hand or on order, last standard price, last control price, purchasing department forecast price and suggested new standard price. These data are reviewed and adjusted where necessary to meet the committee's wishes. At the next meeting of the executive committee the cost department presents its new schedules for depreciation, insurance and taxes, showing these in detail for each cost center, and with comparisons for the preceding period. Since this cost system provides that all costs incurred be ultimately accumulated in the productive cost centers the prorating of distribution basis for the service departments is also presented to the executive committee for review and approval.

**REVIEW OF RESULTS**—In describing the standard cost system of a textile plant the same authority states that the system has been designed to provide analysis of variances by causes and also by cost centers.

The operating executives receive a variance analysis report on each of the cost centers under their control. The foreman is given a monthly budget report showing only his budget allowances, the actual costs and the variations. The operating executives review the budget reports with the foremen each month.

Fig 14 shows (in the last column) the budget standards for a typical cost center. The budget standards shown in this exhibit are those which the executive committee set up at the beginning of the year and which are shown in Fig 15. These budget standards are really allowances based on the standard costs for levels of operation below normal. Therefore if a foreman follows instructions as set in these budget allowances he cannot be charged with a variance which is due solely to volume. For example, Fig 14 shows a variance loss of \$38 on bridging. The budget standard states that the full \$100 is to be allowed at all levels. Consequently this loss is due to the level of operation and is so charged in the variance analysis column. On the supervision item, however, the budget standards provided that the assistant foreman was to go back on the bench below 70%. Apparently this was not done and caused a variation loss of \$80. The foreman is charged with this variation inasmuch as it would not have occurred had he adhered to the budget standard.

**RESPONSIBILITY OF FOREMEN**—Standards are sometimes reviewed by the persons held responsible for their maintenance before being put into effect. Thus in connection with Fig 14 Perry, cited above, states:

After eliminating variations due to volume and management, those which remain are attributable to the foreman. On direct material and labor any variations due to prices or rates have been eliminated so that any variance on these items is due to inefficient usage. Budget variances charged to the foremen are those which result from not following budget standards. The amounts shown in the last column as the foreman's budget for the month are the standard costs adjusted for variations due to the level of operation and variations caused by management.

Giving a foreman or other executive opportunity to express his opinion has two advantages:

- 1 It serves as a check upon work of standards department by bringing up occasional important points that were overlooked.

Account	100% Std	Actual Std Cost	Std Cost at 62%	Variance	Budget Standard	Explanation	Variations			Foreman's Budget Allow
							Oper'n Level	Management	Foreman	
Labor										
Warping										
Setting Up										
Material										
Cones & Tube.										
Sizing										
Burden										
Handling	\$100	\$ 100	\$ 62	\$ 38	Use std on oper rate sheet	10% wage increase		\$ -35	\$ +16	\$ 300
Repairs	40	40	25	+ 15	Use std on oper rate sheet					98
Supervision	90	90	56	+ 34	Use std on oper rate sheet					
Depreciation	150	150	93	+ 57	Use std on oper rate sheet					
Insurance	10	10	6	+ 4	Use std on oper rate sheet					
Taxes	20	20	13	+ 7	Use std on oper rate sheet					
Boiler & Power	40	40	25	+ 15	Use std on oper rate sheet					
Plant & Bldg	20	20	13	+ 7	Use std on oper rate sheet					
	\$230	\$ 607	\$ 392	\$ 215						
Grand Total		\$1 384	\$1 112	\$ 272						

FIG 14 Schedule Showing Responsibility for Manufacturing Expense Variance



2 It is a good way to present the standard for any feeling that the standard was imposed from without or any misunderstanding concerning its nature can be disposed of in the discussion. The provision of such an opportunity for operating executives to familiarize themselves with what has been done and the fair treatment of any objections that are voiced goes far toward securing an agreement on the fairness of the standards. Once this has been reached, more cooperation in enforcing standards can be expected and responsibility for unfavorable variances cannot be shifted by questioning the validity of the standards.

**RESPONSIBILITY OF MANAGEMENT**—Not all responsibility rests on the foreman. Management must assume its share. Thus speaking of the results in Fig 14, Peery (NACA Bulletin vol 22) states:

The variations charged to management are those which occur due to changes over which the foreman has no control such as in this case a 10% wage increase. It is this column which provides the flexibility necessary to keep the foreman's budgets right up to date for it absorbs any variations caused by management changes since the standards were set. This column also keeps the executives informed as to the cost of the changes which they have instituted.

**REVISION OF STANDARDS**—Current standard costs must be changed when prices, manufacturing methods, product specifications, or other circumstances change to such an extent that the standard no longer represents a good measure of performance. It is also necessary to change standards which are found to have been incorrectly set. This should be done only when the existing standard is clearly erroneous for the objective of standards is defeated if management does not resist any tendency to lower standards rather than to raise performance. Many concerns review all standard costs once a year and make changes at that time.

**Procedure in Changing Current Standards**—When standard costs are changed, it is necessary to revise inventory and surplus or income accounts if the changes are to be retroactive. On the other hand if changes are to apply only to goods manufactured in future, no adjustment of the accounts is required. Changes in the standard price of materials or correction of erroneous usage and utilization standards generally affect only the work performed subsequent to the revision of standard costs. When jobs already started are to be finished under the old standards and new jobs are to come under different standards it is convenient to open new ledger accounts for work to which the changed standards apply. Two sets of Work in Process accounts are thus carried for a time but the old accounts are closed as soon as jobs in process under the old standards are completed.

Reitell and Johnston (Cost Accounting) describe the procedure as follows:

Such changes affect the Work in Process Inventory accounts (if any of the commodities whose unit costs are altered are in process) and the Finished Goods Inventory account also the Raw Materials Inventory account if the changes in unit costs are due to alterations in material standard prices and some of the particular materials are on hand. When the new inventory values have been calculated the old inventory accounts are closed by being credited for their balances and new inventory accounts are

opened which are debited with the new inventory values. The difference between the new and old inventory values is debited or credited direct to Profit and Loss account or to a special reserve account. A reserve account is used when it is expected that part of the inventory contents will still be on hand at the end of the first period of the new year.

The use of a special reserve account necessitates an adjustment at the end of each month of the new year crediting or debiting the special reserve account and debiting or crediting Profit and Loss account for a portion of the amount originally posted to the special reserve account. When all the inventory on hand at the beginning of the year has disappeared the reserve account should be in balance and no further adjusting entries will be required. If a balance sheet is prepared while the reserve account has a balance this balance is shown as a deferred asset or deferred liability. Since material work in process and finished goods are credited out at the new standard rates the apparent gain or loss due to altering the inventory values at the beginning of the year is offset when the product is sold. For example if at the beginning of the year the material inventory is written up because of increases in standard rates for material the cost of materials issued during the year and therefore the cost of goods manufactured and sold during the year will correspondingly increase. The increase in cost of goods sold will offset the apparent profit due to the write up of the raw material inventory at the beginning of the year.

**Revising Basic Standards**—Basic standard costs are revised only when methods of manufacturing change or when plant capacity changes, or when the disparity between the basic standard and expected performance becomes so great that the standard loses its significance. This is in contrast to current standards which require complete revision each year as new budgets are prepared. Since the principal value of basic standards lies in their use as fixed points or bench marks from which to measure changes they must remain as stable as possible. Under the basic plan less trouble arises even if the standards are not exact since the comparisons are relative.

## Organizing Standard Cost Records

**TYPES OF STANDARD COST RECORDS**—A complete set of standard cost cards and records must be prepared. These begin with manufacturing specification cards showing how each operation is to be performed and what elements of material, labor, and services should be consumed. These physical specifications are then priced at standard costs and the results posted to standard cost cards which show the standard cost of each element entering into a unit of product. The number and complexity of these cards depend upon the size and characteristics of the business. A plant producing thousands of different articles naturally has need for many more cards than one producing a single article. The presence of a complicated manufacturing process in which parts are produced and then brought together into subassemblies before completion also requires more highly organized standard cost records than one where the manufacturing process is simple. However no great difficulties are involved for the standard cost cards can be organized on the same principle now familiar in handling accounting records, that is the records are arranged to follow operation sequence details being provided where needed, and then posted in summary as

COST SHEET—DATE \_\_\_\_\_  
(Centers and bulk packages)  
Product \_\_\_\_\_

	Costs Are per Pound		
	Quantity	Price	Amount
MATERIAL			
Corn Syrup	\$	\$	\$
Sugar			
Chocolate			
Fruits and Nuts			
Flavoring and Coloring			
Total Material	_____	_____	_____
% Waste			
Total Material			<u>\$</u>
	</		

FIG 16 Test Run" Cost Sheet



## A

### STANDARD RAW MATERIAL and PURCHASED PART COST RECORD

Class of Material Brass Sheets

Price Level Date Jan 1, 19—

Class or Symbol	Description	Price Per Cwt
B1	80/20 Red Brass	
	22 Ga x 6 x 60	19 50
	22 Ga x 18 x 60	21 50
	22 Ga x 18" x 72	22 50
	20 Ga x 3 x 72	21 50
	20 Ga x 8 x 60	19 00
	1/8 x 3	20 00
	1/8 x 4	
	1/8 x 17	
	1/8 x 19	

As recorded on Fig 2-Standard Parts Chart

## B

### STANDARD RAW MATERIAL and PURCHASED PART COST RECORD

Class of Material U S Hex Hd Capscrews

Price Level Date Average 19—

Class or Symbol	Description	Price Per 100
S1-1	1/1 x 1/2	38
S1-2	1/4 x 5/8	36
S1-3	1/4 x 3/4	40
S1-4	1/4 x 7/8	42
S1-5	1/4 x 1"	43
S1-6	1/4 x 1 1/2"	45
S1-7	1/4 x 2	48
S1-8	1/4 x 2 1/2	54
S1-9	5/16 x 1/2	40
S1-10	5/16 x 3/4	43
S1-11	5/16 x 7/8	46
S1-12	5/16 x 1	47
S1-13	5/16 x 1 1/2	

As recorded on Fig 1-Standard Raw Material List

FIG 17 Standard Raw Material and Purchased Part Cost Record

STANDA

ACCOUNT		A/C CLASS	TIME OR QUANTITY				
NUMBER	NAME		PER CENT OF CAPACITY				
			50	60	70	80	
6 2001	Supervision	A					
6 2002	Clerical	A					
6 2003	Misc Non Prod Lab	B					
	Etc						
6 2051	Supplies	E					
6 2052	Sundry Expense	E					
	Etc						
	Grand Total						
	STANDARD DISTRIBUTION	%					
Dept 1	Lathe Dept	54.3					
Dept 2	Grinder Dept	35.7					

Distribution as determined from engineering analysis of consumption

Distribution as determined from engineering analysis of consumption

## STANDARD EXPENSE

ACCOUNT		A/C CLASS	TIME OR QUANTITY						RATE	
NUMBER	NAME		PER CENT OF CAPACITY OPERATION						AMOUNT	PER
			50	60	70	80	90	100		
6 0201	Supervision	A	1	1	2	2	2	2	175.00	Mo
6 0202	Clerical	A	1	1	1	1	1	1	100.00	Mo
6 0203	Misc Non Prod Lab	B	240	240	360	360	480	480	40	Hr
6 0206	Rep & Maint Machy	C	360	180	480	480	480	480	55	Hr
Etc	Etc									
6 0251	Supplies	E								
6 0252	Sundry Expense	E								
6 0256	Rep & Maint - Machy	G								
Etc	Etc									
	Total Direct									
6 0297	General Factory Exp	L								
6 0298	Power Expense	L								
6 0299	Depr Insurance & Taxes	L								
	Grand Total									
STANDARD PRODUCTIVE HOURS & AMTS								1032.3		
STANDARD BURDEN RATE										

FIG 18 Standard



the item progresses until at completion a single figure representing the completed standard cost of a product results.

**STANDARD COST RECORDS FROM TEST RUNS**—Development of standard product costs and the resulting cost records for a small confectionery plant by use of test runs is described as follows by Bennett and Fiske (N I C A Bulletin, vol 17)

The standard product costs will be determined on the basis of a series of test runs. Initially each and every item in the line will have to be studied in one or more tests. Having once been set up they will only be changed as fundamental cost conditions change. Beyond the occasional tests of new products and rechecks on old items, no attention will be given to so called actual or job order costs.

For the accumulation of the costs of test runs two forms of cost sheets are provided. The first is designed to develop the costs of hard candies of caramels of the various flavors and grades of centers and of bulk packed dipped goods. It is illustrated here as Fig 16. A second cost sheet is intended for assorted packages.

Both cost sheets accumulate material, labor and factory burden totals without allowing them to become mixed. This is important for the making of routine periodic cost entries. Both provide for the inclusion in the case of sale goods of commercial expense of interest and discounts and of standard profit. All unit costs are in terms of pounds rather than of packages which vary in content weight.

**SUMMARY AND SUPPORTING RECORDS OF STANDARDS**—The form of summary record should be varied to suit conditions existing in each plant or industry. Fig 19 is a condensed specimen of a form used by a company in recording the standard cost of musical instrument parts and assemblies. Details of material, kind and quantity, and labor operations and piecework rates are shown on Figs 1, 2 and 9 prepared by the engineering staff. The standard material price \$19 per cwt, is as recorded on form A, Fig 17. The third cost element standard burden cost is calculated at a standard rate as determined on a standard expense distribution sheet similar to Fig 18.

In musical instrument production many assemblies are started in production routine as raw parts. After one or more labor operations a second part is added after which the combined parts go through further processing. A third fourth and fifth part may be added with processing between each addition. This combined assembling and processing makes a part and assembly cost record shown in Fig 20.

In gasoline engine production processing and assembly routines are somewhat different. In such plants most parts are machined or otherwise processed individually and carried in stock as finished parts. Where finished products are so complex, it is impractical to attempt complete assembly from individual parts. This difficulty is overcome by making up subassemblies. Final product assembly then consists of combining these subassemblies with such individual parts as do not readily lend themselves to subassembly. A logical plan for building standard costs should therefore, parallel the practice in the factory. Figs 20 and 21 illustrate standard parts cost, standard assembly cost and standard specification cost records for an engine manufacturing plant. These records too, are simply an assembling and combination of previously established basic data. On form A Fig 20 the kind and quantity of material are as specified on blueprints. The standard material price is

STANDARD FACTORY COST PER 100													
PART NAME Alto Saxophone Bow Cap					PART No 1723								
LABOR					MATERIAL								
DEPT NO	OPER. NO.	OPERATION NAME	STD HOURS	RATE	STD LABOR COST	ENTRY POINT	DESCRIPTION	GROSS QUAN	STD PRICE	COST	SCRAP QUANT	VALUE	NET STD MAT'L COST
4	1	Blank	2	Pw	10	10	8" x 20 64 90% Gross	17.625	19	2.40	44	40	2.00
4	2	Piece	2	"	11								
4	3	1st Form	2	"	10								
4	4	2nd Form	6		36								
COMPONENT PARTS													
						ENTRY POINT	PART NO.	NAME OF PART			NO USED	STD LABOR COST	
						67							
STANDARD COST SUMMARY													
12/6/-													
Material 2.00													
Labor 67													
Burden 160% 1.07													
Total 3.74													

FIG 19 Standard Cost Record

A STANDARD PART COST					
Part No. <u>1-44</u>		Name <u>Cylinder</u>			
Make From <u>G.I. Casting</u>		Part <u>1-24</u>			
STANDARD LABOR COST PER 100					
OPERATION		STANDARD HOURS	RATE	STANDARD COST	
NUMBER	NAME				
M 10	Mill Top	14.2	PW	8.00	
M 11	Mill Bottom	10.3		6.50	
B 76	Rgn Bore	6.2	57	3.22	
D 32	Fin Bore	12.0	PW	7.50	
D 89	Drill 6-3/8"	5.3	"	2.50	
		34.15		190.35	
STD MATERIAL & SUMMARIZED COST PER 100 PIECES					
MATERIAL		100PCS	1090.25	1090.25	
SCRAP & WASTE CREDIT					
STANDARD MATERIAL COST				1090.25	
STANDARD LABOR COST				190.35	
STANDARD BURDEN COST 160%				304.86	
				1585.16	

B STANDARD ASSEMBLY COST					
Assem. No. <u>5A1-44</u>		Name <u>Cylinder Assembly</u>			
STANDARD COST OF PARTS IN 100 ASSEMBLIES					
ENTRY POINT	PART NO.	NO OF PIECES	STANDARD HOURS	STANDARD COST	
				MATERIAL	LABOR
1320	A1-44	1	34.15	1090.25	190.35
"	21-2	2	-	35.50	
"	21-3	2	-	32.00	
"	21-31	1	-	19.10	
TOTALS			34.15	1320.75	190.35

FIG 20 Standard Part and Assembly Cost Records

STANDARD SPECIFICATION COST RECORD PER 100 ENGINES								
Model <u>2C</u> For <u>Continental Trading Corp</u>			Spec No. <u>AU 69 36</u>					
ASSEMBLY OR FIT GROUP NUMBER	NAME	NO. USED	COMPILED 5/2/—			REVISED SPEC		
			STD. HOURS	STANDARD MATERIAL	STANDARD LABOR	STD. HOURS	STANDARD MATERIAL	STANDARD LABOR
AU 69 16	Engine Assem.	1	1817.4	3924.50	1017.72			
UA	Unit Hous Assem	1						
PU	Pour Unit Assem	1						
AI	Cylinder Assem	1						
9F 50	Fittings	1		50.91				
A2 6	Cyl Head Assem	1	72.2	229.10	44.72			
F2 6	Fittings	1		19.95				
A3	Oil Pan Assem	1						
F3	Fittings	1						
A5	Crankshaft Assem	1						
F5	Fittings	1						
A31	Retainer	1						
F6	Camshaft Fittings	1						
A1	Conn Rod Assem	4						
F7	Fittings	4						
A10 4	Manifold Intake	1	24.0	55.60	12.60			
10 16	Exhaust	1	36.0	72.00	17.20			
65	Conn	1						
F10 4	Fittings	1		5.18				
A31-	Clutch Hous Assem	1						
F31	Fittings	1						
A13	Transmission Assem	1						
F13-	Fittings	1						
Assembly Labor								
A162	Fin Assem Engine		92.3		60.00			
A210	Fit Accessories		20.2		12.50			
T41	Test		59.4		42.75			
TOTALS			2150.8	5792.65	1642.07			
Labor				1642.07				
Burden				3284.14				
TOTAL STD FACTORY COST				10718.80				

FIG 21 Standard Specification Cost Record

as recorded on forms similar to Fig. 17. Labor operations and piecework prices are as specified on records such as illustrated in Fig. 9. Standard burden rate is as determined on standard expense schedules (Fig. 18).

**Labor and burden data** on form B, Fig. 20, come from the same sources as in the case of form A. The list of component parts is obtained from specification analysis records (Fig. 7). Standard hours and standard material and labor costs of these parts are posted from the summary portion of the standard parts cost (form A).

Building of **standard specification cost records** is a similar routine. Symbol numbers and quantities used of assemblies and parts groups which make up a complete engine are obtained from standard specification index sheets (Fig. 8). Standard hours, and standard material and labor costs are posted from standard part and standard assembly cost records forms A and B on Fig. 20. Labor operations and piecework rates in assembly routine are as illustrated on form C, Fig. 9.

The above presentation makes it amply evident that standard costs are merely one phase of a general movement that has as its aim the standardization of every element of business management. To establish standard costs an operating philosophy must be kept in view comprising the establishment of standards for every phase of plant operation—that is, standards for each element of manufacturing cost, of commercial cost and even standards for profit (see Section 2 on Profit graphs). In the development of such standard costs the cost accountant works in close collaboration with the engineer and the plant executives.



## SECTION 7

### OPERATION OF STANDARD COSTS

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## SECTION 7

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### OPERATION OF STANDARD COSTS

#### Standards in Books of Account

**INCORPORATING STANDARD COSTS IN THE ACCOUNTS**—Standard costs are generally incorporated into the cost accounts, although some concerns prefer to use them purely for statistical comparisons. In general, incorporating standard costs into the regular double entry records has the same advantages that come from having historical cost accounts "tied in" with the financial accounts viz

- 1 Accuracy of clerical work is improved when double entry balancing techniques are used.
- 2 Data drawn from the accounts receive more serious attention from executives.

Those who view standard costs as the true costs, naturally introduce standard costs into the ledgers and financial statements. When the accounts are properly handled accuracy and reliability of financial statements are enhanced.

**BOOKKEEPING METHODS WITH STANDARD COSTS**—Considerable variation exists in bookkeeping methods for handling standard costs. Practically all these methods can be classified as one of three principal types according to the manner in which the Work in Process account is handled.

- 1 Partial Plan Entering debits to Work in Process account at actual cost and credits to Work in Process for goods completed at standard cost.
- 2 Single Plan Entering both debits and credits to Work in Process account at standard cost.
- 3 Dual Plan Entering debits and credits to Work in Process account at both actual and standard cost.

**TYPES OF VARIANCE CALCULATIONS**—Variances from standard cost can be expressed in either absolute or relative numbers. In the first instance, the variance is computed by subtracting actual cost from standard cost. If the actual exceeds the standard cost the variance is a negative figure (i.e. unfavorable and represents a variance loss), if actual cost is less than standard cost the variance is a positive figure (i.e. favorable and represents a variance gain). This method of expressing variances is thus one which centers the attention of management upon dollar amounts of variation from standard costs.

By the second method the variance is computed by dividing the standard cost figure into the actual cost figure to obtain the actual cost as a percentage of standard cost. Since standard cost is always the base for comparison the standard cost is considered 100%. When actual cost has thus been converted to percentages of standard the actual cost percentage figure can be subtracted from the standard cost percentage figure (100%). The result which may be either positive or negative depending upon whether actual cost is less or greater than standard cost is the cost **variance** expressed as a percentage of standard cost. In contrast with the preceding method, a **relative variation** from standard is thus provided.

These two methods present complementary aspects of the cost figures in such a manner that both are required for a complete understanding of the cost variation that has taken place. Variances which are large in terms of dollars are sometimes so small in terms of percentages that they pass unnoticed by management if presented in the latter form alone; on the other hand a large percentage variation may call attention to a substantial deviation from **standard efficiency**, yet the present actual loss in terms of dollars may be small.

**ILLUSTRATION OF STANDARD COST BOOKKEEPING METHODS**—The example on the succeeding pages illustrates the

MATERIALS			
Kind	Quantity	Standard Unit Cost	Totals
M-1	5 units	\$1 00	\$ 5 00
M-2	2 units	7 00	14 00
M-3	12 units	2 00	24 00
Total Material Cost			\$ 43 00
DIRECT LABOR			
Operation Number	Standard Hours	Standard Rate per Hour	
1	5	\$ 50	\$ 2 50
2	15	60	9 00
3	3	75	2 25
4	7	95	6 65
Total Hours	30		
Total Cost			20 40
OVERHEAD			
		Rate per Direct Labor Hour	Standard Hours
Department A (Operations 1 & 2)		\$1 00	20
Department B (Operations 3 & 4)		3 00	10
			30 00
Standard Unit Cost			50 00
			\$113 40

FIG. 1 Standard Cost Card—Product Z

Item	MONTH OF _____ 19____						
	0 1 w h 0%	20 000 k w h 20%	40 000 k w h 40%	60 000 k w h 60%	80 000 1 w h 80%	100 000 k w h 100 %	120 000 k w h 120%
Supervision	\$200 00	\$200 00	\$ 200 00	\$ 200 00	\$ 200 00	\$ 200 00	\$ 200 00
Powerhouse Labor	140 00	172 00	204 00	236 00	268 00	300 00	332 00
Fuel	240 00	292 00	344 00	396 00	448 00	500 00	552 00
Wages	60 00	76 00	92 00	108 00	124 00	140 00	156 00
Supplies	20 00	35 00	50 00	65 00	80 00	95 00	110 00
Maintenance	25 00	60 00	95 00	1 0 00	165 00	200 00	235 00
Depreciation	50 00	50 00	50 00	50 00	50 00	50 00	50 00
Taxes	15 00	15 00	15 00	15 00	15 00	15 00	15 00
	\$750 00 *	\$900 00	\$1 050 00	\$1 200 00	\$1 350 00	\$1 500 00	\$1 650 00

\* Fixed or stand by cost

## Normal cost per Kwh

$$\text{Fixed element} \quad \frac{750}{100 000} = \$ 0075$$

$$\text{Variable element} \quad \frac{750}{100 000} = 0075$$

$$\text{Total (100 000 Kwh = Normal capacity) = } \$ 015$$

FIG 2 Power Plant Flexible Budget

		MONTH OF _____ 19__					
	0	400	800	1 200	1 600	2 000	2 400
	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs
	0%	20%	40%	60%	80%	100%	120%
	Capacity	Capacity	Capacity	Capacity	Capacity	Capacity	Capacity
Supervision	\$ 250.00	\$ 290.00	\$ 330.00	\$ 370.00	\$ 410.00	\$ 450.00	\$ 490.00
Indirect Labor	337.50	474.00	590.50	707.00	823.50	940.00	1 056.50
Supplies	30.00	36.00	42.00	48.00	54.00	60.00	66.00
Depreciation	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Taxes	75.00	75.00	75.00	75.00	75.00	75.00	75.00
Power	187.50	225.00	262.50	300.00	337.50	375.00	412.50
	\$1 000.00 *	\$1 200.00	\$1 400.00	\$1 600.00	\$1 800.00	\$2 000.00	\$2 200.00

\* Fixed or stand by cost

## Normal overhead rate per direct labor hour

$$\text{Fixed element} \quad \frac{\$1\,000}{2\,000} = \$\,50$$

$$\text{Variable element} \quad \frac{\$1\,000}{2\,000} = 50$$

$$\text{Total (2 000 hrs = normal capacity)} = \$1\,00$$

Fig 3 Flexible Overhead Budget—Department A

		MONTH OF _____ 19__					
		0	200	400	600	800	1 000
Hrs	Capacity	Hrs	Capacity	Hrs	Capacity	Hrs	Capacity
0	0%	200	20%	400	40%	600	60%
Hrs	Capacity	Hrs	Capacity	Hrs	Capacity	Hrs	Capacity
1 200	120%	1 200	120%	1 200	120%	1 200	120%
Supervision	\$ 225 00	\$ 250 00	\$ 275 00	\$ 300 00	\$ 325 00	\$ 350 00	\$ 375 00
Indirect Labor	100 00	125 00	150 00	175 00	200 00	225 00	250 00
Maintenance	100 00	120 00	140 00	160 00	180 00	200 00	220 00
Depreciation	1 000 00	1 000 00	1 000 00	1 000 00	1 000 00	1 000 00	1 000 00
Supplies	37 50	50 00	62 50	75 00	87 50	100 00	112 50
Power	362 50	675 00	787 50	900 00	1 012 50	1 125 00	1 237 50
	\$2 025 00 *	\$2 220 00	\$2 415 00	\$2 610 00	\$2 805 00	\$3 000 00	\$3 195 00

\* Fixed or stand by cost

## Normal overhead rate per direct labor hour

$$\text{Fixed element} \quad \frac{\$2 025}{1 000} = \$2 025$$

$$\text{Variable element} \quad \frac{\$ 975}{1 000} = \underline{\underline{\$ 975}}$$

$$\text{Total (1 000 hrs = normal capacity)} = \underline{\underline{\$3 000}}$$

FIG 4 Flexible Overhead Budget—Department B

operation of the manufacturing accounts by following step by step, the flow of costs from the initial purchase of materials and services to the final summary of results in the financial statements. The company is assumed to be one which has two productive departments (Department A and Department B) and one service department, which is a power plant. The product goes through four operations, the first two of which are carried out in Department A, while operations 3 and 4 are carried out in Department B. Three kinds of material (designated as M 1, M 2, and M 3) are used, the first two being issued at the beginning of operation 1 and the third at the time work enters operation 3.

Entries and statements are based upon the standard cost card (Fig. 1), flexible budgets (Figs. 2-4) and the statement of transactions given below.

**Statement of Transactions**—The following transactions are assumed to have occurred during the month.

1. Purchases of materials

Kind	Units	Actual Unit Price	Actual Cost	Standard Cost
M-1	1 000	\$ .85	\$ 850 00	\$ 1 000 00
M-2	500	.770	3 850 00	3 500 00
M-3	5 000	2.20	11 000 00	10 000 00
			<u>\$15 700 00</u>	<u>\$14 500 00</u>

(There is no initial inventory.)

2. Materials put into process—standard quantities

Kind	Units	Standard Cost	Actual Cost
M-1	500 (for 100 product units)	\$ 500 00	\$ 425 00
M-2	200 (for 100 product units)	1 400 00	1 540 00
M-3	1 080 (for 90 product units)	2 160 00	2 376 00
		<u>\$4 060 00</u>	<u>\$4 341 00</u>

Excess materials issued

Kind	Units	Standard Cost	Actual Cost
M-1	20	\$20 00	\$17 00
M-2	5	35 00	38 50
		<u>\$55 00</u>	<u>\$55 50</u>

3. Direct labor used

Operation	Standard Hours	Actual Hours	Actual Rate	Standard Labor Charge	Actual Payroll	
1	500	525	\$ .50	\$ 250 00	\$ 262 50	(for 100 product units)
2	1 500	1 540	.65	900 00	1 001 00	(for 100 product units)
3	240	230	.80	180 00	184 00	(for 80 product units)
4	560	560	.90	504 00	504 00	(for 80 product units)
				<u>\$1 862 00</u>	<u>\$1 051 50</u>	



## 4 Overhead costs applied

Department	Normal Rate	Standard Hours Produced	Actual Hours Worked	Charged to Work in Process
A	\$1 00	2 000	2 065	\$2 000 00
B	3 00	800	790	2 400 00
				<u>\$4 400 00</u>

## 5 Actual overhead costs incurred

## POWER PLANT—

Item	Actual Cost
Supervision	\$ 200 00
Powerhouse labor	295 00
Fuel	470 00
Water	135 00
Supplies	87 50
Maintenance	185 00
Depreciation	50 00
Taxes	15 00
Total	<u>\$1 437 50</u>

## DEPARTMENT A—

Item	Actual Cost
Supervision	\$ 400 00
Indirect labor	945 00
Supplies	50 00
Depreciation	100 00
Taxes	75 00
Power (25 000 kWh used)	275 00
Total	<u>\$2 011 00</u>

## DEPARTMENT B—

Item	Actual Cost
Supervision	\$ 210 00
Indirect labor	215 00
Maintenance	190 00
Depreciation	1 000 00
Supplies	90 00
Power (65 000 kWh used)	1 050 00
Total	<u>\$2 870 00</u>

## 6 Work completed during month

Department A	100 units completed and transferred to Department B
Department B	80 units completed and transferred to finished goods

## 7 Sales

50 units at \$175 00 each

## Accounting for Partial Plan

### Charging Work in Process at Actual Cost

**CHARACTERISTICS OF PARTIAL PLAN**—There are three distinctive features that characterize this method of standard cost keeping, namely

- 1 Debits to Work in Process are entered at actual cost credits to Work in Process account are entered at standard cost. Thus raw materials inventories are carried at actual cost and finished goods inventories are carried at standard cost. Cost of goods sold is computed at standard cost.
- 2 Variances from standard cost are collected at the end of the accounting period after work in process has been inventoried.
- 3 Variances from standard cost appear as a total difference between standard and actual cost. Analysis of these variance figures requires the aid of information not available in the accounts.

The journal entries for this method are shown below followed by explanations of the entries and figures. The latter are carried through to the variance calculations, the ledger accounts (Fig. 6), and the financial statements.

### JOURNAL ENTRIES FOR PARTIAL PLAN—

- 1 Entry for purchase of raw materials
 

Raw Materials	\$15 700 00	
Vouchers Payable		\$15 700 00

To record actual cost of materials purchased. Subsidiary stores ledger is kept in the usual manner using actual costs.
- 2 Entry for direct material put into process
 

Work in Process—Department A	\$2 020 50	
Work in Process—Department B	2 376 00	
Raw Materials		\$4 396 50

To charge departmental Work in Process accounts with actual cost of materials put into process.
- 3 Entry for direct labor cost incurred
 

Work in Process—Department A	\$1 263 50	
Work in Process—Department B	888 00	
Payroll		\$1 051 50

To charge departmental Work in Process accounts with actual cost of direct labor used in productive departments.
- 4 Entry for overhead costs applied
 

Work in Process—Department A	\$2 065 00	
Work in Process—Department B	2 370 00	
Overhead Cost—Department A		\$2 065 00
Overhead Cost—Department B		2 370 00

To charge departmental Work in Process accounts with applied overhead costs. Above figures are calculated by multiplying actual hours worked by normal overhead rate. (This is a partial deviation from the use of actual costs for charging Work in Process accounts but conforms to the widespread use of normal overhead rates for costing goods manufactured.)

## 5 Entries for actual overhead costs

## a Recording service department costs—

Power Cost	\$1 407 00	
Vouchers Payable etc		\$1 437 50
to charge Power Costs account with actual costs of operating this service department		

## b Distributing service department costs to productive departments—

Overhead Cost—Department A	\$ 375 00	
Overhead Cost—Department B	1 050 00	
Power Cost		\$ 1 425 00

To charge departmental overhead accounts with budgeted cost of power used. Fixed costs of power plant are distributed to operating departments in ratio of their capacities to demand service (25% to A 75% to B), variable costs are charged at standard cost of \$ 0075 per kWh consumed

## c Recording producing department direct overhead cost—

Overhead Cost—Department A	\$1 636 00	
Overhead Cost—Department B	1 920 00	
Vouchers Payable etc		\$3 456 00
To charge departmental account with actual direct overhead		

## 6 Entries for work completed during month

## a Transferring semi-finished material from Department A to Department B—

Work in Process—Department B	\$3 050 00	
Work in Process—Department A		\$5 050 00
To transfer 100 product units from Department A to Department B at standard cost		

## b Recording goods finished—

Finished Goods	\$9 072 00	
Work in Process—Department B		\$9 072 00
To transfer 80 completed units from Department B to finished goods inventory at standard cost		

## 7 Entries for sales

## a Recording selling price—

Accounts Receivable	\$8 750 00	
Sales		\$8 750 00
To record sale of 50 units at \$175 00 each		

## b Recording cost price—

Cost of Sales	\$5 670 00	
Finished Goods		\$5 670 00
To transfer standard cost of goods sold from Finished Goods to Cost of Sales		

## 8 Entry for Inventory of Work in Process

Work in Process—Department B (New)	\$1 200 00	
Work in Process—Department B (Old)		\$1 250 00
To record standard cost of work in process inventory (See explanation below)		

## 9 Closing expense and revenue accounts

Sales	\$8 750 00	
Overhead Cost—Department A	54 00	
Cost of Sales		\$5 670 00
Work in Process—Department A		290 00
Work in Process—Department B		162 00
Overhead Cost—Department B		500 00
Power Cost		12 50
Profit and Loss		2 100 50
To close nominal account balances		

After all variances have been analyzed (see explanation, page 334) the variance balances remaining in the accounts and other expense and revenue items are closed to Profit and Loss.

**CALCULATION OF WORK IN PROCESS INVENTORY —**

At the end of the month the balances in Work in Process accounts are composed of two elements: (1) standard cost of unfinished work and (2) variances from standard cost. These latter apply both to the unfinished work and to the work which was completed and transferred to finished goods during the month. For Work in Process account has been credited only for the standard cost of goods finished. The first step in effecting a separation of work in process inventory from variances is an inventory of goods in process. Material, labor, and overhead contained in this inventory are priced at standard cost. It is necessary to take into consideration the **stage of completion** reached by multiplying the aggregate standard cost of the product units on hand by a fraction representing the average degree of completion.

Another method which has been suggested by Gillespie (*Accounting Procedure for Standard Costs*) is to arrange the **standard cost card** to show a cumulative cost from which can be read the unit standard cost incurred at the completion of each operation in the manufacturing process. Rearranging the standard cost card (Fig. 1) in this fashion it would appear as shown in Fig. 5. The following figures illustrate the calculation of the standard cost of work in process at the end of the month:

Inventory of work in process	
Department A	0 units
Department B	20 units

It is found that these 20 units have not yet entered process 3, but are on hand in the shape form in which they were transferred from Department A. However, 120 units of material M 3 have been issued in preparation for starting process 3. Thus, according to the standard cost card (Fig. 1), is equivalent to the M 3 material requirements for 10 product units. The standard cost of the work in process is, therefore:

$$\begin{array}{rcl}
 20 \text{ units} \times \$50.50 & = & \$1 010.00 \text{ Fig. 5, line 2, col. (1)} \\
 10 \text{ units} \times 24.00 & = & 240.00 \text{ Fig. 5, line 3, col. (b)} \\
 \hline
 & & \underline{\$1 250.00}
 \end{array}$$

By an adjusting entry the standard cost of work in process on the closing date is recorded (entry 8). Since all work put through processes 1 and 2 has been finished and transferred to Department B, no adjusting entry is needed for Department A.

Operation Number	Material		Labor		Overhead		Total Cost	
	Operation Cost	Cumulative Cost	Operation Cost	Cumulative Cost	Operation Cost	Cumulative Cost	Operation Cost	Cumulative Cost
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
1	\$ 5.00	\$ 5.00	\$2.50	\$ 2.50	\$ 5.00	\$ 5.00	\$12.50	\$ 12.50
2	14.00	19.00	9.00	11.50	15.00	20.00	38.00	50.50
3	24.00	43.00	2.25	13.75	9.00	29.00	1.25	50.75
4			6.65	20.40	21.00	50.00	27.65	118.40

FIG. 5 Cumulative Standard Cost Card—Product Z (by operations completed)

**GROSS VARIANCES**—The final result is that Work in Process accounts have been debited with actual cost and credited with the standard cost of all manufacturing during the period, the balances remaining in Work in Process accounts represent the difference between the actual and standard costs of the work done.

This difference between standard and actual costs is an algebraic sum of variances flowing from a number of causes and it is necessary to analyze the aggregate figure representing the total or gross variance according to the factors responsible for the variance. While this can be readily accomplished information from sources outside the accounting records is needed. The process of analysis and the sources from which essential data can be secured are outlined below.

**Direct Material Cost Variances**—In order to separate material price and material usage variances it is necessary to know

- 1 Actual physical usage of each material
- 2 Actual cost of material used
- 3 Standard physical usage of each material
- 4 Standard unit cost of each material

Since by this method raw materials are charged to Work in Process at actual cost the requisitions show actual usage and actual cost of materials used. In order to calculate the price variance, one additional figure actual usage extended at standard unit price is needed. Thus the formula for computing material price variances is

$$\text{Material price variance} = \text{Actual usage} \times (\text{Standard unit cost} - \text{Actual unit cost})$$

The variances for each type of material are

$$\begin{array}{ll} \text{Material M-1} & 520 \times (\$1.00 - \$ .85) = \$ 78.00 \text{ gain} \\ \text{Material M-2} & 205 \times (7.00 - 7.70) = 143.50 \text{ loss} \\ \text{Material M-3} & 1,080 \times (2.00 - 2.20) = 216.00 \text{ loss} \end{array}$$

\$281.50 loss

Calculation of usage variance calls for knowledge of total standard quantity of material contained in the goods produced. This figure is secured by multiplying the physical units produced during the period by the standard unit usage quantities. Care must be used to include in the standard material usage figure only such materials as should have been used in bringing the unfinished product units to the stage of completion that they have reached on the closing date of the period. The formula is

$$\text{Material usage variance} = \text{Standard unit price} \times (\text{Standard quantity of material in product} - \text{Actual quantity of material used})$$

The variances for each type are

$$\begin{array}{ll} \text{Material M-1} & \$1.00 \times (500 - 520) = \$20.00 \text{ loss} \\ \text{Material M-2} & 7.00 \times (200 - 205) = 35.00 \text{ loss} \\ \text{Material M-3} & 2.00 \times (1,080 - 1,080) = 0.00 \end{array}$$

\$55.00 loss

**Direct Labor Cost Variances**—The required data are

- 1 Actual hours of labor used
- 2 Actual rate paid
- 3 Standard hours contained in attained production
- 4 Standard rate

The first of these figures is obtainable from a summary of clock cards, payroll summary, etc., and the actual cost of this time is available in payroll records. The number of standard hours must be obtained by multiplying the production figures for the month by the standard unit labor usage. With unfinished units still in process, the standard quantity of labor in the product at the stage of completion reached must be used. The standard rate is taken from the standard cost card.

The formula for labor rate variance is

$$\text{Labor rate variance} = \text{Actual hours used} \times (\text{Standard hourly rate} - \text{Actual hourly rate})$$

The labor rate variance figures are

Operation 1	525 × (\$ 50 — \$ 50)	= \$ 0 00
Operation 2	1 540 × ( 60 — 65)	= 77 00 loss
Operation 3	230 × ( 75 — 80)	= 11 50 loss
Operation 4	560 × ( 95 — 90)	= 28 00 gain
		<u>\$60 50 loss</u>

The formula for the labor usage or efficiency variance is

$$\text{Labor usage variance} = \text{Standard labor rate} \times (\text{Standard labor hours} - \text{Actual labor hours})$$

The labor efficiency variance figures are

Operation 1	\$ 50 × ( 500 — 525)	= \$12 50 loss
Operation 2	60 × (1 500 — 1 540)	= 24 00 loss
Operation 3	75 × ( 240 — 230)	= 7 50 gain
Operation 4	95 × ( 560 — 560)	= 0 00
		<u>\$29 00 loss</u>

**OVERHEAD VARIANCES**—Overhead or manufacturing expense variances are usually of three types

- 1 Expense variance
- 2 Efficiency variance
- 3 Utilization variance

The expense variance is the result of spending more or less than the budgeted allowances for indirect materials, indirect labor, etc., at the attained activity level.

The efficiency variance, also called **controllable variance**, is the result of using more or less than the standard amount of overhead service. It arises whenever the actual direct labor hours or machine hours differ from the standard allowed hours.

The utilization variance, frequently referred to as **capacity variance**, or volume variance, is the result of operating more or less than the normal number of hours in any given budget period.

**Required Data**—To compute overhead variances it is necessary to obtain

- 1 Actual overhead for period
- 2 Actual number of direct labor hours (or other units if overhead is not distributed on basis of direct labor hours)
- 3 Budgeted overhead for period
- 4 Number of standard labor hours in the product
- 5 Normal overhead rate

**Sources of Data**—The sources of these data are

- 1 Actual overhead is obtained by summing debits in departmental overhead accounts (departmental expense distribution sheet)
- 2 Actual number of direct labor hours is compiled from clock cards
- 3 Budgeted overhead is obtained from the flexible budgets (Figs 2-4) by selecting figures corresponding to the actual number of direct labor hours worked. In the case of Department A actual hours worked are 2065 against 2000 normal. The budget allowance for 2065 hours is obtained by interpolation in the flexible budget (Fig. 3). Since the variable cost per hour is \$50 the budget for 2065 hours is arrived at as follows

Fixed or transfer charges	\$1 000 00
Variable charges (2065 × \$50)	1 032 50
Total	<u>\$2 032 50</u>

- Similarly the budget for the 790 hours actually worked in Department B (Fig. 4) is as follows

Fixed charges	\$2 025 00
Variable charges (790 × \$075)	770 25
Total	<u>\$2 795 25</u>

- 4 The number of standard direct labor hours in production is found by multiplying the units produced by the standard labor hour content per unit as shown by the standard cost card
- 5 The normal overhead rate is obtained from the standard cost card

**Formulas for Overhead Variances**—These are as follows

- 1 Overhead expense variance = (Budgeted overhead cost at actual activity level) - (Actual overhead cost)
- 2 Overhead efficiency variance = (Normal overhead rate × Standard direct labor hours in product) - (Normal overhead rate × Actual direct labor hours in product)
- 3 Overhead utilization variance = (Normal overhead rate × Actual direct labor hours in product) - (Budgeted overhead cost at actual activity level)

These formulas yield the following variance figures

Department A	
Expense variance	= \$2 032 50 - \$2 011 00 = \$ 21 50 gain
Efficiency variance	= \$1 00 (2 000 - 2 065) = 65 00 loss
Utilization variance	= \$2 065 00 - \$2 032 50 = 32 50 gain



*Department B*

Expense variance	= \$2 795 25 - \$2 870 00 =	\$ 74 75 loss
Efficiency variance	= \$3 00 (800 - 790) =	30 00 gain
Utilization variance	= \$2 370 00 - \$2 795 25 =	425 25 loss

For other methods of computing overhead variances see Section 2

**SERVICE DEPARTMENT VARIANCE**—As a first step in obtaining a variance for service departments it is necessary to make service department expense distributions. The power plant costs of operation are typical and are illustrated below

**Power Cost Distribution**—Department A (Fig. 3) requires when operating at normal capacity, 25,000 kwh of power monthly, and Department B (Fig. 4) requires at normal capacity 75,000 kwh monthly. Hence, Department A is responsible for one-fourth of power plant capacity and Department B for three-fourths. Fixed costs of the power plant, which represent stand by costs of providing this capacity to supply 100,000 kwh per month are therefore distributed to the two productive departments in the above ratios. The fixed power cost distribution based on the flexible budget (Fig. 2) is

To Department A	$\frac{1}{4} \times \$750.00 =$	\$187 50
To Department B	$\frac{3}{4} \times 750.00 =$	<u>562 50</u>
		<u>\$750 00</u>

Variable costs of generating power are charged to producing departments at a standard unit rate determined by dividing total budgeted variable power costs at normal capacity (\$1 500—\$750) by the number of kilowatt hours generated when the power plant is operating at normal capacity (100 000). The calculations are

$$\$750.00 \div 100,000 = \$0.0075 \text{ per kwh}$$

This serves to distribute the variable costs of generating power to the producing departments in the ratio of actual power consumption as follows

To Department A	$\$0.0075 \times 25,000 =$	\$187 50
To Department B	$0.0075 \times 75,000 =$	<u>562 50</u>
		<u>\$750 00</u>

This double basis of power cost distribution is advocated by Schlatter (Advanced Cost Accounting) who contends fixed power costs should be apportioned on the basis of consumption of current at normal capacity (i.e. capacity ratios) while variable power costs are to be distributed on the basis of actual consumption (consumption ratios). In this way, a finer service cost distribution results when actual operations are more or less than normal capacity.

**Power Plant Variance**—The power plant has spent \$12 50 more than its budget allowance for the month and hence there is an expense variance of this amount chargeable to the power plant. While only 90% of the power plant's normal capacity has been used, no utilization variance appears in the power plant accounts because all fixed costs pertaining to it have been distributed to producing departments. Hence idleness in the power plant increases the utilization variance of producing departments, in this case Department B, since Department A operated at normal capacity.

## PROFIT AND LOSS STATEMENT

MONTH OF JUNE 19—

Sales	\$8 750 00
Cost of Sales (standard) (Schedule 1)	<u>5 670 00</u>
Gross Manufacturing Margin	\$3 080 00
Add Unfavorable Variances (Schedule 1)	<u>919 50</u>
Profit from Manufacturing	<u>\$2 160 50</u>

## STANDARD COST OF SALES

(Schedule 1)

Raw Materials Purchased	\$15 700 00	
Less Inventory at end	<u>11 303 50</u>	
Materials Consumed (actual)		\$ 4 396 50
Direct Labor (actual)		<u>1 051 50</u>
Manufacturing Expense (actual)		<u>4 893 50</u>
Current Manufacturing Charges (actual)		\$11 241 50
Less Work in Process Inventory at end (standard)		<u>1 250 00</u>
Cost of Production		\$ 9 991 50
Less Finished Goods Inventory at end (standard)		<u>3 402 00</u>
Cost of Sales—unadjusted		\$ 6 589 50
Less Unfavorable Variances		
Material Usage	\$ 55 00	
Material Price	<u>291 50</u>	\$ 336 50
Labor Time	\$ 29 00	
Labor Rate	<u>60 50</u>	89 50
Power Expense	\$ 12 50	
Overhead Expense	<u>53 25</u>	
Overhead Efficiency	35 00	
Overhead Utilization	<u>992 75</u>	493 50
Cost of Sales (standard)		<u>\$ 5 670 00</u>

## BALANCE SHEET JUNE 30 19—

Assets	
Accounts Receivable	\$ 8 750 00
Raw Materials (actual cost)	<u>11 303 50</u>
Work in Process Inventory (standard)	<u>1 250 00</u>
Finished Goods (standard)	<u>3 402 00</u>
Total Assets	<u>\$24 705 50</u>
Equities	
Vouchers Payable	\$20 593 50
Payroll	<u>1 951 50</u>
Net Profit from Manufacturing	<u>2 160 50</u>
Total Equities	<u>\$24 705 50</u>

**PARTIAL PLAN IN PRACTICE**—An application of the method of charging Work in Process at actual cost by a manufacturer of wax crayons and chalk has been described by Chubbuck and Nickerson (N A C A Bulletin vol 21)

RAW MATERIALS		WORK IN PROCESS—DEPT A	
(1) \$15 700 00	(2) \$ 1 308 50	(7) \$ 2 020 50	(8a) \$ , 050 00
	Bal 11 303 50	(3) 1 203 50	(9) P&I 200 00
<u>\$15 700 00</u>	<u>\$15 700 00</u>	(4) 9 065 00	
Bal \$11 303 50		<u>\$ 5 349 00</u>	<u>\$ 5 349 00</u>
POWER COST		WORK IN PROCESS—DEPT B	
(5d) \$ 1 437 50	(5b) \$ 1 195 00	(2) \$ 2 376 00	(6b) \$ 9 072 00
	(9) P&I 12 50	(3) 688 00	(8) Bal 1 200 00
<u>\$ 1 437 50</u>	<u>\$ 1 437 50</u>	(4) 2 370 00	(9) P&I 102 00
		(8a) 5 050 00	
		<u>\$10 484 00</u>	<u>\$10 484 00</u>
OVERHEAD COST—DEPT A		(8) Bal \$ 1 250 00	
(5b) \$ 300 00	(4) \$ 2 005 00	FINISHED GOODS	
(5c) 1 688 00		(9b) \$ 9 072 00	(7b) \$ 5 070 00
(9) P&I 84 00			Bal 3 402 00
<u>\$ 2 065 00</u>	<u>\$ 2 005 00</u>	<u>\$ 9 072 00</u>	<u>\$ 8 472 00</u>
OVERHEAD COST—DEPT B		Bal \$ 3 102 00	
(5b) \$ 1 040 00	(4) \$ 2 370 00	COST OF SALES	
(5c) 1 820 00	(9) P&I 500 00	(7b) \$ 5 070 00	(9) P&I \$ 5 670 00
<u>\$ 2 860 00</u>	<u>\$ 2 870 00</u>	ACCOUNTS RECEIVABLE	
		(7a) \$ 8 750 00	
PAYROLL		SALES	
	(3) \$ 1 051 50	(9) P&I \$ 8 750 00	(7a) \$ 8 750 00
VOUCHERS PAYABLE ETC		PROFIT AND LOSS	
Bal \$90 593 50	( ) \$15 700 00		(9) \$ 2 100 00
	(8a) 1 437 50		
	(5c) 3 408 00		
<u>\$90 593 50</u>	<u>\$90 593 50</u>		
Bal \$90 593 50			

FIG 6 Ledger Accounts for Partial Plan Standard Costs

**Material Costs**—Material purchases are charged through suitable general ledger accounts a separate account being kept for each major division of raw materials. The monthly material consumption is calculated at the end of each month by taking a physical inventory of materials on hand. Raw materials accounts are credited and Materials in Process debited for the actual quantities of each class of raw materials used during the month priced on a first-in first out basis. The debit side of Materials in Process is thus made up of the opening balance plus the actual cost of materials consumed in production.

Against these debits in Work in Process credits are made at end of month

- 1 For standard values of materials in products finished during month
- 2 For standard values of materials still in process

The balance in the account is the **material variance** for the month which may be analyzed according to material classifications or by departments (Fig 7), and from which **price and usage** variances may also be computed.

## ADJUSTMENTS OF STANDARD COSTS FOR MATERIALS

FOR THE MONTH OF \_\_\_\_\_ 19\_\_

Classification	Materials	Materials	Materials	Materials	Standard	Standard	Standard
	in Process Beginning of Month— Actual	Put in Process— Actual	Total	Consumed in Production— Standard Basis	End of Month	Actual	Over or Under ie Materials Overabsorbed or Unabsorbed
BY CLASSES OF MATERIALS							
Wax							
Color—Dry							
do —Pulp							
Clay and Plaster							
Wax Boxes							
Chalk Boxes							
Shipping Boxes—Wood							
do —Corrugated							
Modeline							
TOTAL							

## BY DEPARTMENTS

Department	
Wax Crayon	
Dustless Chalk	
Chalk	
Modeline	
TOTAL	

FIG 7 Analysis of Material Consumption and Variance

In Fig. 7 the first column represents the actual materials in process at the beginning of the month priced at standard cost. The second column is for the actual cost of materials put into process during the month. The third column is the total of the first two columns. The fourth column represents materials in products finished during the period priced at standard cost. The fifth column is the difference between columns three and four and as the residual it represents the value of the ending inventory together with all materials price and quantity variances between actual and standard for the month. Column six represents the actual quantity of work in process at the end of the month established by physical count and priced at standard cost. Column seven is the difference between columns five and six.

**Labor Costs**—The manufacturer in question has made careful time studies for every direct labor operation, the results being expressed in the form of standards as time allowances in minutes per gross. Production is carefully planned and supervised, as a result, most labor efficiency variances occur on new products not yet properly standardized.

Daily production reports show the quantities produced of each item, the standard allowance and extension for each. They also show waiting time together with a statement of the reasons therefor.

Labor variances arising from differences in labor rates paid are compared with the standard labor rate. Variances which are due to other causes are also determined, such as loss from breakage of clayons in transit between departments.

**Manufacturing Burden**—Reference to Fig. 8 shows the basis for the distribution of budgeted amounts for manufacturing expenses to producing and service departments and the redistribution of service departments to the manufacturing departments which they serve.

**Manufacturing burden rates** are expressed as a percentage of the budget for each department to its direct labor. The accounting for manufacturing burden is as follows:

The total of all manufacturing expenses for the month is credited to a burden clearing account and debited to an account called Manufacturing Expenses Incurred, both carried under the accrued items section in the general ledger. An amount representing one twelfth of the annual manufacturing expenses is then credited to this account. Manufacturing Expenses Incurred and debited to Work in Process account.

The credit to the Work in Process account for burden included in finished product is the sum of the products of the departmental standard direct labor included therein multiplied by the respective burden rates.

The burden rates are based on capacity to sell, i.e., on expected activity, rather than on capacity to produce. The latter is probably more common (see Section 20 Overhead and Normal Capacity).

## Accounting for Single Plan

### Charging Work in Process at Standard Cost

**CHARACTERISTICS OF SINGLE PLAN**—The distinguishing feature of the single plan is that both debits and credits to Work in Process are entered at standard cost. Under this method, some carry raw materials inventory at standard cost, while others keep it at actual

## MANUFACTURING DEPARTMENTAL

Item	Total Budget	BUDGET—PRODUCTIVE DEPARTMENTS						
		Wax		Stand Chalk		Duress Chalk		Mod'g City
		Mldg	Packing	Mldg	Packing	Mldg	Packing	
Superintendent	—							
Supervisors	—	—	—	—	—	—	—	—
Indirect Labor	—							
Fuel	—							
Purchased Power	—							
Water	—							
Supplies	—							
Freight in	—							
Repairs—Buildings	—	—	—	—	—	—	—	—
Machinery	—	—	—	—	—	—	—	—
Experimental Ex-								
penses	—							
Electros	—							
Taxes	—	—	—	—	—	—	—	—
Insurance	—	—	—	—	—	—	—	—
Depreciation	—	—	—	—	—	—	—	—
Totals—All De-								
partments	—	—	—	—	—	—	—	—
Heat and Power	—	—	—	—	—	—	—	—
Gen Burden and								
Rec'g and Ship-	—	—	—	—	—	—	—	—
ping								
Total Burden—Pro-								
ductive Depart-	—	—	—	—	—	—	—	—
ments								
Total Fixed Burden								
—Productive De-	—	—	—	—	—	—	—	—
partments								
Total Idle Space and								
Machinery								
Direct Labor	—	—	—	—	—	—	—	—
Burden Rates	—	—	—	—	—	—	—	—
Fixed Burden in-								
cluded in Rates	—	—	—	—	—	—	—	—

FIG 8 Budgeted Expense Distrib

## BUDGET AND BURDEN RATES

		BUDGET—Nonproductive Departments					Basis of Distribution
Printing	Total Prod Depts	Heat and Power	General Burden	Rel g & Shipping	Idle Space & Machinery	Total Non prod Depts	
—	—	—	—	—		—	To General Burden Experience
		—	—	—		—	To Heat and Power
		—	—	—		—	
		—	—	—		—	To General Burden
—	—	—	—	—		—	Floor Area
—	—	—	—	—		—	Machinery Age & Valuation
—	—	—	—	—		—	To General Burden
—	—	—	—	—	—	—	To Printing
—	—	—	—	—	—	—	Property Taxes—Departmental Valuation Social Security—Factory Payroll (Buildings)—Floor Area (Machinery & Equipment)—Value
—	—	—	—	—	—	—	(Electric Power)—Weighted Horsepower
—	—	(—)	—	—	—	—	(Electric Light)—Weighted Watts
—	—	—	—	—	—	—	(Steam) — Consumption based on test
—	—	—	(—)	(—)			Payroll of Productive Departments
—	—						
—	—						
—	—						
—	—						Shown as separate item on Profit and Loss statement
—	—						
—	—						
—	—						

bution (as basis for normal rates)

cost. There are also organizations which carry some items, usually supplies, to be charged to overhead accounts at actual cost and the remainder of the materials at standard cost. In a study made by the Research and Service Department of the National Association of Cost Accountants (N. A. C. A. Bulletin, vol. 18), the following inventory practices were found for 197 companies:

	Number	Percentage
Purchased materials charged at invoice price	177	89.9
Purchased materials charged at standard cost	17	8.6
Purchased materials charged at both actual and standard cost	3	1.5
	<u>197</u>	<u>100.0</u>

Thus a distinct preference exists for carrying purchased material inventories in the ledger at actual cost. Of the 17 companies charging purchases at standard cost, 9 reported use of standard cost as a basis for inventory valuation on the balance sheet.

Where the stores account is debited at standard, the price variance is separated from actual cost when materials are charged to stores and the usage variance appears when materials are put into process. Under the alternative plan, both price and usage variances appear when materials are put into process.

An objection to keeping raw materials inventories at standard cost is that **price variances** may not appear in the same period in which the materials are actually put into production. If the plant follows the practice of charging variances to Profit and Loss in the period in which the variances arise, there may be marked fluctuations in net profit that have no connection with production and sales. This effect upon the profit and loss statement can, however, be avoided by setting up price variances as **deferred items** to be written off as materials are put into process or as goods are sold. The journal entries and ledger accounts in Fig. 9 show the different methods for handling the Stores account. The first two produce of course different results. The third is a compromise between the other two. Under the third method a **price variance suspense** account is created at the time the invoice is recorded. When stores are issued the suspense account is adjusted. Any balance in the suspense account is treated like a valuation item, being added to or deducted from the standard stores value. Thus the same price variance is obtained as under the first method. On the balance sheet, the compromise method works out as follows:

Stores (standard)	\$2 000 00	
Material Price Suspense	<u>1 000 00</u>	\$3 000 00

The net effect is the same as when the price variance is recorded at the time of issue.

Fig. 10 is an illustration of the actual procedure involved in obtaining material price variances at the time of purchase. Forms A and B on Fig. 10 illustrate the recording of values at actual cost, standard cost, and the variation between the two. The vendor's invoices at time of audit for the correctness of billing detail are stamped with an analysis block such as that illustrated by form A. After audit and vouchering the vendor's invoices are recorded by the cost department on a form such as "B".



I Price Variance at Time of Purchase		II Price Variance at Time of Issue		III Price Variance at Purchase and Issue	
(1)		(1)		(1)	
Stores	\$3 000	Stores	\$1 500	Stores	\$3 000
Material Price Variance	1 500	Accounts Payable	\$4 500	Material Price Surplus Account, Payable	1 500
To record purchase of 3 000 units at \$1.50 each	\$4 500	To record purchase of 3 000 units at \$1.50 actual cost		To record purchase of 3 000 units in Stores account at standard cost of \$1.00 each	\$4 500
(2)		(2)		(2)	
Work in Process	1 000	Work in Process	1 000	Stores	
To record issuance of 1 000 units at \$1.00 standard cost		Material Price Variance	500	To record issuance of 1 000 units at \$1.00 standard cost	1 500
Stores		Stores		Stores	
(1) Std	\$3 000	(1) Act	\$4 500	(1) Act	\$1 500
(2) Std	1 000	(2) Act	3 000	(2) Act	3 000
Bal (Std)	2 000	Bal (Act)	3 000	Bal (Act)	3 000
	<u>\$3 000</u>		<u>\$4 500</u>		<u>\$4 500</u>
Work in Process		Work in Process		Work in Process	
(2) Std	\$1 000	(2) Std	\$1 000	(2) Std	\$3 000
Material Price Variance		Material Price Variance		Material Price Variance	
(1)	\$1 500	(1)	\$ 500	(1)	\$3 000
Material Price Variance		Material Price Variance		Material Price Variance	
(1)	\$1 500	(1)	\$ 500	(1)	\$3 000
Material Price Variance		Material Price Variance		Material Price Variance	
(1)	\$1 500	(1)	\$ 500	(1)	\$3 000
Material Price Variance		Material Price Variance		Material Price Variance	
(1)	\$1 500	(1)	\$ 500	(1)	\$3 000

FIG. 9 Methods for Handling Material Price Variances

material variations (Fig. 10). Monthly totals of actual charges are controlled by the total charges to the raw material inventory accounts in the voucher register.

**JOURNAL ENTRIES FOR SINGLE PLAN**—Bookkeeping entries illustrating the application of the single plan to the same data used in the partial plan scheme are given below. The ledger accounts are shown in Fig. 11.

1 Entry for raw materials purchased

Raw Materials	\$14 500 00	
Raw Material Price Suspense	1 200 00	
Vouchers Payable, etc.		\$15 700 00
To charge Raw Materials account with standard cost of materials purchased		

2 a Entry for raw materials put in process—

Work in Process—Department A	\$ 1 900 00	
Work in Process—Department B	2 160 00	
Raw Material Usage Variance	55 00	
Raw Materials		\$ 4 115 00
To charge departmental Work in Process accounts with standard cost of standard quantity of materials used		

b Entry for material price variance—

Raw Material Price Variance	\$ 281 50	
Raw Material Price Suspense		\$ 281 50
To record price variance on materials consumed		

	No. of Units	Standard	Actual
M-1	520*	\$ 520 00	\$ 442 00
M-2	205*	1 435 00	1 578 50
M-3	1 080	2 160 00	2 376 00
		<u>\$4 115 00</u>	<u>\$4 396 50</u>
Price variance		281 50	
		<u>\$4 396 50</u>	<u>\$4 396 50</u>

\* Includes excess materials issued

3 Entry for direct labor cost incurred

Work in Process—Department A	\$ 1 150 00	
Work in Process—Department B	712 00	
Labor Rate Variance	60 50	
Labor Usage Variance	29 00	
Payroll		\$ 1 951 50
To charge departmental work in process accounts with standard cost of standard quantities of labor		

4 Entry for overhead costs applied

Work in Process—Department A	\$ 2 000 00	
Work in Process—Department B	2 400 00	
Overhead Cost—Department A		\$ 2 000 00
Overhead Cost—Department B		2,400 00
To charge departmental work in process accounts with standard overhead cost determined by multiplying actual production by normal overhead rate		

ANALYSIS OF PRICE VARIATIONS				MATERIAL VARIATIONS			
INVT NO	QTY	STD VALUE	VARIATION	STANDARD	ACTUAL	VARIATION	STANDARD
104 17	100.00	98.00	* 2.00	98.00	98.00	* 2.00	98.00
104 16	45.10	48.15	3.05	48.15	45.10	3.05	48.15
A				145.10	146.15	1.05	145.10

ACCOUNT 104 12 G.I. Cost			
MONTH July 19--			
STANDARD	ACTUAL	VARIATION	VOUCHER NO
98.00	98.00	* 2.00	G 116
48.15	45.10	3.05	G 117
145.10	146.15	1.05	G 118
145.10	145.10	0.00	G 119
145.10	145.10	0.00	G 120
145.10	145.10	0.00	G 121
145.10	145.10	0.00	G 122
145.10	145.10	0.00	G 123
145.10	145.10	0.00	G 124
145.10	145.10	0.00	G 125
Etc			
Etc			

RUBBER STAMP USED ON VOUCHER INVOICES  
 B

\* Indicates increase in cost over standard

## 5 Entries for actual overhead costs

## a Recording service department costs—

Power Cost	\$ 1 437 50	
Vouchers Payable etc		\$ 1 437 50
To charge power plant account with actual costs incurred		

## b Distributing service department costs to productive departments—

Overhead Cost—Department A	\$ 375 00	
Overhead Cost—Department B	1 050 00	
Power Co t		\$ 1 425 00
To charge productive departments and credit power plant with standard cost of actual quantity of power used		

## c Recording productive department direct overhead costs

Overhead Cost—Department A	\$ 1 636 00	
Overhead Cost—Department B	1 820 00	
Vouchers Payable etc		\$ 3 456 00
To charge departmental overhead accounts with actual overhead costs		

## 6 Entries for work completed during month

Work in Process—Department B	\$ 5 050 00	
Work in Process—Department A		\$ 5 050 00
To record transfer at standard cost of 100 completed units from Department A to Department B		
Finished Goods	9 072 00	
Work in Process—Department B		9 072 00
To record transfer at standard cost of 80 completed units from Department B to Finished Goods		

## 7 Entries for sales

Accounts Receivable	\$ 8 750 00	
Sales		\$ 8 750 00
To record sale of 50 units at \$175 00 each		
Cost of Sales	5 670 00	
Finished Goods		5 670 00
To transfer standard cost of goods sold from Finished Goods to Cost of Sales		

## 8 Entry to close expense and revenue accounts to Profit and Loss

Sales	\$ 8 750 00	
Raw Material Price Variance		\$ 281 50
Raw Material Usage Variance		55 00
Labor Rate Variance		60 50
Labor Usage Variance		20 00
Power Cost		12 50
Overhead Cost—Department A		11 00
Overhead Cost—Department B		470 00
Cost of Sales		5 670 00
Profit and Loss		2 160 50
To close expense and revenue accounts		

Explanations where necessary in support of the above entries are presented below. The resulting ledger accounts are shown in Fig. 11 and can be traced through to the financial statements. Note that the results are the same as for the single plan, but that the form of the cost of sales schedule is different.

**RAW MATERIAL COSTS**—If raw materials inventory is to be kept at standard cost. Raw Materials account is debited with the standard cost of materials as they are received. Accounts Payable is credited with the actual cost, the difference is entered in a Material Price Variance account as a debit when actual cost exceeds standard cost and as a credit when actual cost is less than standard cost.

If raw materials inventories are to be kept at actual cost entries are made in the same way that is customary where standards are not in use.

**Stores Ledger under Standard Costs**—Balance of stores ledger cards generally show quantity figures only, for it requires much less clerical effort to multiply the quantity of material on hand by the standard unit cost when the value of the inventory is wanted than it does to keep a running balance in value terms. Thus use of standard costs can effect considerable reduction in the cost of bookkeeping. A large amount of computation is necessary when inventories are kept at actual cost and materials are charged out by the first in first out, average cost or last in first-out method. Since under standard costs materials are accounted for at a price which does not change so long as the same standards are in force periodic multiplication of total quantities by standard prices can be substituted for the many routine calculations and value entries necessary under actual costs. A copy of the receiving report serves as a source of data for entries in the subsidiary stores ledger, since this report is prepared as soon as the materials arrive and the availability of materials is thus promptly reflected in the stores records. Later when invoices arrive, they are extended at standard cost and entries in the Raw Materials controlling account, Accounts Payable, and Price Variation account are made.

**Material Usage Variance**—Since the Work in Process account is carried entirely at standard cost under this method it should be charged with the standard cost of the standard quantity of materials allowed for each production order. Any difference between the standard quantity and the quantity actually issued is priced at standard cost and entered in a Material Usage Variance account. The Raw Materials account receives a corresponding credit entry at the standard price.

There are two ways of obtaining data needed as a basis for entries just described. These are:

- 1 To enter standard quantities and standard costs on requisitions and to post them either in detail or in summary to the ledger accounts. It is common practice to require that a separate requisition be prepared and approved for materials in excess of the standard quantity. This is a very useful device in the control of material costs because it calls attention to the quantity variance at the time it arises. There is also time to order materials returned to stores if investigation shows their use is avoidable.

- 2 To summarize production accomplished during the period and to price this at standard cost rates. When this method is in use quantity

RAW MATERIALS				RAW MATERIAL PRICE SURPENSE			
(1)	\$14 500 00	(2)	\$ 4 115 00	(1)	\$ 1 200 00	(2b)	\$ 281 50
		Bal	10 385 00			Bal	918 50
	<u>\$14 500 00</u>		<u>\$14 500 00</u>		<u>\$ 1 200 00</u>		<u>\$ 1 200 00</u>
Bal	\$10 385 00			Bal	\$ 918 50		
LOWER COST				RAW MATERIAL PRICE VARIANCE			
(5a)	\$ 1 437 50	(5b)	\$ 1 495 00	(2b)	\$ 281 50	(8) P&L	\$ 281 50
		(8) P&L	12 50				
	<u>\$ 1 437 50</u>		<u>\$ 1 437 50</u>				
OVERHEAD COST—DEPT A				RAW MATERIAL USAGE VARIANCE			
(5b)	\$ 375 00	(4)	\$ 2 000 00	(7)	\$ 55 00	(8) P&L	\$ 55 00
(5c)	1 636 00	(8) P&L	11 00				
	<u>\$ 2 011 00</u>		<u>\$ 2 011 00</u>				
OVERHEAD COST—DEPT B				DIRECT LABOR RATE VARIANCE			
(5b)	\$ 1 050 00	(4)	\$ 2 400 00	(3)	\$ 60 50	(8) P&L	\$ 60 50
(5c)	1 820 00	(8) P&L	470 00				
	<u>\$ 2 870 00</u>		<u>\$ 2 870 00</u>				
PAYROLL				DIRECT LABOR USAGE VARIANCE			
		(3)	\$ 1 951 50	(3)	\$ 20 00	(8) P&L	\$ 20 00
VOUCHERS PAYABLE I C				FINISHED GOODS			
\$20 503 50	(1)	\$10 700 00	(6)	\$9 072 00	(7)	\$ 5 670 00	
	(5a)	1 437 50			Bal	3 402 00	
	(5c)	3 456 00				<u>\$ 9 072 00</u>	
		<u>\$20 503 50</u>		Bal	\$3 402 00		<u>\$ 9 072 00</u>
	Bal	\$20 503 50					
WORK IN PROCESS—DEPT A				COST OF SALES			
(2)	\$ 1 000 00	(0)	\$ 5 050 00	(7)	\$ 5 670 00	(8) P&L	\$ 5 670 00
(3)	1 150 00						
(4)	2 000 00						
	<u>\$ 5 050 00</u>		<u>\$ 5 050 00</u>				
WORK IN PROCESS—DEPT B				ACCOUNTS RECEIVABLE			
(2)	\$ 2 100 00	(6)	\$ 6 072 00	(7)	\$ 8 750 00		
(3)	712 00	Bal	1 750 00				
(4)	2 400 00						
(6)	5 050 00						
	<u>\$10 322 00</u>		<u>\$10 322 00</u>				
Bal	\$ 1 250 00			PROFIT AND LOSS			
						(8)	\$ 2 100 50

FIG 11 Ledger Accounts for Single Plan Standard Costs

variances are not available until the work has been done and it is then too late to save unnecessary materials

**LABOR COSTS AND VARIANCES**—The debit to Work in Process is for the standard quantity of direct labor priced at the standard rate. However the Accrued Payroll account must be credited for the actual cost of the actual time worked since it represents a liability to employees for this amount. The rate and usage variations are separated and recorded in variance accounts at same time the charge to Work in Process is made. Data needed to prepare these entries and sources of information are the same as under the partial plan.

**MANUFACTURING EXPENSE**—After the departmental overhead accounts have been charged for actual overhead incurred they have the following debit balances which represent over-all variances from standard.

Power Cost	\$ 12 50
Overhead Cost—Department A	11 00
Overhead Cost—Department B	470 00

These aggregate variances are analyzed according to causes and yield the same results as under the partial plan. If desired these variances may be analyzed in the ledger by transferring them to separate accounts.

#### STATEMENT OF PROFIT AND LOSS

MONTH ENDED JUL 30 19\_\_

Sales	\$8 750 00
Cost of Sales (actual) (Schedule 1)	6 589 50
Profit from Manufacturing	<u>\$2 160 50</u>

#### COST OF SALES

(Schedule 1)

Standard Raw Material Cost	\$ 4 000 00	
Standard Direct Labor Cost	1 862 00	
Standard Overhead Cost	4 400 00	
Standard Current Manufacturing Charges	<u>\$10 322 00</u>	
Less Work in Process Inventory at end (standard)	1 250 00	
Standard Cost of Production	<u>\$ 9 072 00</u>	
Less Finished Goods Inventory at end (standard)	3 402 00	
Standard Cost of Sales	<u>\$ 5 670 00</u>	
Add Unfavorable Variances		
Material Usage	\$ 25 00	
Material Price	281 50	\$306 50
Labor Time	\$ 20 00	
Labor Rate	60 50	80 50
Power Expense	\$ 12 50	
Overhead Expense	53 25	
Overhead Efficiency	35 00	
Overhead Utilization	<u>392 75</u>	<u>403 50</u>
Cost of Sales (actual)		<u>\$ 6 089 50</u>

## BALANCE SHEET JUNE 30, 19\_\_

<b>Assets</b>		
Accounts Receivable		\$ 8 750 00
Raw Materials Inventory (standard)	\$10 385 00	
Raw Material Price Suspense	<u>918 50</u>	
		11 303 50
Work in Process Inventory (standard)		1 250 00
Finished Goods Inventory (standard)		3 402 00
Total Assets		<u>\$24 705 50</u>
<b>Equities</b>		
Vouchers Payable		\$20 593 50
Payroll		1 951 50
Net Profit from Manufacturing		2 160 50
Total Equities		<u>\$24 705 50</u>

**CLOSING OUT VARIANCES**—The ultimate disposal of cost variances arising under the partial or single plan is a matter concerning which there exist different lines of opinion. In general, the method advocated is determined by the accountant's attitude toward standard costs. The methods in use and reasons advanced in support of each are summarized below:

- 1 Close out to Profit and Loss or to Cost of Sales
- 2 Distribute to inventories and Cost of Sales
- 3 Close out to reserve accounts

**Closing Variances to Profit and Loss**—Those who favor this method present the following arguments:

1 The standard cost represents the proper or justifiable cost of manufacture. This view has been well expressed by Henry W. Maynard (*N. A. A. Year Book* 1928):

Manufacturing control is enhanced and efficiency, economies, and profits promoted by the establishment of precise standards for such of the cost elements and factors as may be standardized in the given plant. These are definitely adopted as the proper, suitable and normal costs of manufacture; they are the costs of the product; the corresponding values are carried into the inventory accounts of work in process and finished stock, and appear on the company's balance sheet as the proper value of current assets; and they form the basis of the cost of sales figures given on the operating statement when the goods are sold. The variances from standard represent unsuitable and improper charges, not a part of normal manufacture; they are a definite loss through operations and as such are not to be temporarily capitalized in the work in process inventory and the company's balance sheet but are usually written off to profit and loss as of the month in which they occur.

Maynard, however, excepts a large utilization variance, which he charges to Cost of Goods Sold as sales of merchandise are made.

2 Standard costs provide inventory valuations that are conservative for they do not include in inventory figures the cost of wastes, losses, inefficiencies, and excessive overhead from low volume of production. If the standards are normal costs the effect of cyclical price swings is likewise removed to a considerable extent and the inventory is valued at a lower figure in times of inflationary prosperity and at a higher figure in times of extreme depression than under actual cost methods.



3 Standard costs make **statements** available at an earlier date because inventory valuations are easier to obtain at standard cost than at actual cost

4 Gross profit margin as a measure of merchandising activities is more readily comparable from month to month when variations in manufacturing cost are excluded from it by entering only standard costs in the Cost of Goods Sold account

5 Executives are more certain to notice variances and to take action to prevent their recurrence when these variances are set out in the profit and loss statement as losses or gains. On the other hand the need for managerial action is obscured when variances are combined with cost of goods manufactured or set up as reserves

A variation of the method of closing variances to Profit and Loss is to close them to Cost of Sales. If it is done for all variances it has the effect of converting the standard cost of sales into an actual cost of sales. Although the method is attractive because of its simplicity on theoretical grounds it cannot easily be defended. Thus according to Schlatter if the variances represent cost of goods they relate to inventories as well as to the goods sold. If they represent real losses or gains they cannot be cost of goods whether sold or unsold.

**Distribution of Variances**—By distributing variances over inventories and cost of goods sold both these items are shown at actual cost in the financial statements. While variances are kept in separate ledger accounts these accounts are regarded as valuation accounts to be closed into inventory and cost of goods sold accounts when the financial statements are prepared. In support of this procedure, the following reasons are given:

1 Only **actual costs** should be admitted to the financial statements. Sanders (Cost Accounting for Control) states that auditors generally take the view that gross profit should be stated at actual cost, which of course necessitates closing into cost of goods sold variances applicable to goods that have been sold. The basis for this opinion seems to be an unwillingness to recognize standard costs as **real costs** for standard costs are viewed merely as convenient aids to factory management and not as costs suitable for use in the income statement. On the other hand actual costs are regarded as facts and as such it is felt that they should be used in the financial statements regardless of their effect. It might also be argued that the public at large is unfamiliar with standard costs and is unable to understand statements containing them. However published statements have long reported inventories and cost of sales figures in which overhead is included at a standard rate.

2 Variances from standard costs are not losses but costs and hence should be reflected in **inventory valuations**. Furthermore charging off variances in the period in which they arise distorts the net profit figures.

3 Standards must be accurate and reliable if they are to serve as the basis for inventory values in the balance sheet. During the developmental stage and before their accuracy has been tested it is doubtless best to use actual costs for financial statement purposes.

**Variance Reserves**—Under this method variance gains are considered as reserves to be carried until offset by variance losses. Thus Fletcher (N. A. C. A. Year Book 1928) says

Any considerable variance gains especially from extra activity, are best tucked away in a reserve account against a time of need

If the same line of reasoning is applied to variance losses they might also be brought into the balance sheet as deferred charges although the preponderant weight of opinion is against carrying such balances beyond end of year. However seasonal fluctuations follow a regular and recurrent cycle within a year, and hence the plan of deferring utilization variance balances during a seasonal cycle is entirely workable and is quite widely used. Utilization balances resulting from seasonality in the use of plant should over a complete seasonal cycle cancel out and any amount remaining at the end of a year should then be written off

**Inventory Valuation and Variances**—If the common practice of valuing inventories at the lower of cost or market is followed the effect of variance disposal upon these balance sheet figures is not an important question. The independent auditor tests inventories valued at standard costs by comparing them with market value just as he would an inventory figure stated at actual cost. Sanders (Cost Accounting for Control) says that if the result shows "very little difference from the values on a cost or market basis" the auditors will accept it without question. If the inventory is found to be materially above the market the auditor will ask that it be written down whether it be at standard or at actual. Hence Sanders concludes that

no new problem of inventory valuation arises when standard costs are used the same rules for testing checking and valuing the inventory will apply and the same procedure will be followed

Even those who object to a standard cost basis of valuing labor and materials in inventory generally apply a standard overhead rate if the business is subject to marked fluctuations in output. From a historical point of view, objections to the use of standard costs for inventory valuation seem to have been discarded one by one. Thus the early writers on accounting objected to any inclusion of overhead in costs on ground that advance estimates created arbitrary and fictitious inventory debits. Today practically all cost systems purporting to give actual costs make use of a predetermined burden rate. In fact so common is the practice that most people now think of actual cost as meaning actual material actual labor and normal overhead. Valuation of direct materials and direct labor at standard cost is thus but a step further in the same direction in which accounting has been moving for a generation rather than a sudden break from an actual to a standard cost basis of calculating figures to serve as a basis for financial statements

**Summary of Treatment of Variances**—Treatment of variances from standards may be summarized as follows

- 1 It is essential that variances be reported separately from standard costs when the purpose is that of measuring efficiency of performance and maintaining control over operations
- 2 When variances have served these objects they may be
  - a Written off to Profit and Loss or to Cost of Sales
  - b Prorated to inventories and cost of goods sold
  - c Set up as reserves

The choice seems best left to the accountant's judgment, for there is neither weight of opinion nor compelling reason in favor of any one of the three

### Accounting for Dual Plan

#### Charging Work in Process at Actual and Standard Costs

**RECORDING ACTUAL AND STANDARD COSTS IN COST ACCOUNTS**—Under this method, entries in inventory accounts are made at both standard and actual costs and the two are carried in parallel columns in the ledger accounts. Only actual cost figures are carried into Cost of Sales and to financial statements. Variances are primarily computed in percentage rather than in absolute terms. Both basic and current standards are used in some applications of this method, but in other applications only current standards are used (See Section 6 on basic and current standards)

The cost card (Fig 12) showing assumed basic standard costs is used in the illustration below. It is also assumed that other standard costs previously given for the partial and single plans represent the current standards for the present month. Detailed explanations for entries are given immediately following the journal entries

MATERIALS			
Kind	Units	Basic Unit Standard Cost	Totals
M-1	5	\$ .90	\$ 4.50
M-2	2	7.00	14.00
M-3	12	2.00	24.00
Total Material Cost			\$ 42.50
DIRECT LABOR			
Operation	Basic Standard Hours	Basic Standard Rate	Total
1	5	\$ .40	\$2.00
2	15	.50	7.50
3	3	.65	1.95
4	7	.85	5.95
Total Hours	30	Total Cost	\$17.40
OVERHEAD			
Department	Basic Rate Per Hour	Basic Standard Hours	Total
A	\$1.00	20	20.00
B	3.00	10	30.00
Basic Unit Standard Cost			<u>\$109.90</u>

FIG 12 Basic Standard Cost Card—Product Z

## JOURNAL ENTRIES FOR DUAL PLAN —

1 Entries for raw materials purchased

a Raw Material M-1

Vouchers Payable

Standard Cost Clearing

To record purchase of 1 000 units of M-1

Actual cost 1 000 × \$ 85 = \$850 00

Standard cost 1 000 × \$ 90 = \$900 00

b Raw Materials M-2 and M-3

Vouchers Payable

Standard Cost Clearing

To record purchases of M-2 and M-3

Actual costs

500 × \$7 70 = \$ 3 850

5 000 × 2 20 = 11 000

\$14 850

Standard costs

500 × \$7 00 = \$ 3 500

5 000 × 2 00 = 10 000

\$13 500

Actual Cost		Basic Standard Cost	
\$ 850 00	\$ 850 00	\$ 900 00	\$ 900 00
14 850 00	14 850 00	13 500 00	13 500 00



## 3 Entries for direct labor used

a *Charging actual cost column of Work in Process—**Work in Process—Department A**Work in Process—Department B**Accrual Payroll**To charge departmental Work in Process accounts with actual cost of actual hours*b *Charging standard cost column of Work in Process—**Work in Process—Department A**Work in Process—Department B**Standard Cost Clearing**To charge departmental Work in Process accounts with basic standard cost of basic standard hours in production*

Dept	Units Processed	Basic Unit Labor Cost	Total Basic Standard Cost
A	100	\$9.50	\$ 950.00
B	80	7.90	632.00
			<u>\$1,582.00</u>

Actual Cost		Basic Standard Cost	
\$1,263.70			
688.00			
	\$1,951.70		
		\$ 950.00	
		632.00	
			\$1,582.00

## 4 Entry for overhead costs applied

Work in Process—Department A

Work in Process—Department B

Overhead Cost—Department A

Overhead Cost—Department B

Standard Cost Clearing

To charge actual cost columns of departmental Work in Process accounts with overhead at normal rate for actual hours worked as follows

Dept	Hours Worked (Actual)	Normal Rate	Total Cost
A	2 065	\$1 00	\$2 065 00
B	790	3 00	2 370 00

and to charge standard cost columns with overhead at normal rate for standard hours worked as follows

Dept	Hours Allowed (Standard)	Normal Rate	Total Cost
A	2 000	\$1 00	\$2 000 00
B	800	3 00	2 400 00

Actual Cost	Basic Standard Cost
\$2 065 00	\$2 000 00
2 370 00	2 400 00
\$2 065 00	
2 370 00	\$4 400 00

## 5 Entries for actual overhead costs incurred

a *Recording service department costs—*  
Power Cost

Vouchers Payable

To charge Power Cost account with actual cost for period

b *Distributing power costs to productive department overhead accounts—*

Overhead Cost—Department A

Overhead Cost—Department B

Power Cost

To transfer actual power costs to departmental overhead accounts. Fixed costs are apportioned in ratio of departmental capacities; variable costs apportioned in consumption ratio

c *Recording actual direct productive overhead—*

Overhead Cost—Department A

Overhead Cost—Department B

Vouchers Payable

To charge actual cost column with overhead exclusive of power cost

Actual Cost		Basic Standard Cost	
\$1 437 00	\$1 437 00		
3 8 47			
1 059 03	1 4 7 50		
1 636 00			
1 820 00			
	3 456 00		



## 6 Entries for work completed during month

a *Interdepartmental transfer—*

Work in Process—Department B

Work in Process—Department A

To transfer 100 units of semi finished work from Department A to Department B

Standard cost  $100 \times \$48.00 = \$4,800.00$ Actual cost  $\$4,800.00 \times 1.11438 = \$5,349.00$ b *Transfer to finished goods—*

Finished Goods

Work in Process—Department B

To transfer 80 units of finished work to Finished Goods account

Standard cost  $80 \times \$109.90 = \$8,792.00$ Actual cost  $1,079.15 \times \$8,792.00 = \$9,488.00$ 

Actual Cost		Basic Standard Cost	
\$5,349.00	\$5,349.00	\$4,800.00	\$4,800.00
9,488.00	9,488.00	8,792.00	8,792.00

## 7 Entries for sales

## a On general books—

Accounts Receivable

Sales

To record sales of 50 units at \$175 00

## b On cost records—

Cost of Sales

Standard Cost Clearing

Finished Goods

To record cost of goods sold

Standard cost  $50 \times \$109.90 = \$5,495.00$ Actual cost  $\$5,495.00 \times 1.07916 = \$5,930.00$ 

## y Entries closing expense and revenue accounts

Sales

Overhead Cost—Department A

Cost of Sales

Overhead Cost—Department B

Profit and Loss

To close expense and revenue accounts.

Actual Cost		Basic Standard Cost	
\$8 750 00	\$8 750 00		
5 930 00		\$5 495 00	\$5 495 00
	5 930 00		
\$8 750 00			
50 53	\$5 930 00		
	500 03		
	2 381 50		

tins and metal cans in another account. The other materials listed having no relationship one to the other should be set up as individual accounts.

Items in process are made up of several different raw materials and therefore it is important in grouping these items into work in process inventory accounts that only items using raw materials included in the same raw material accounts be grouped. For each work in process inventory account we have an identical finished goods inventory account to which transfer is made upon completion.

This grouping may introduce an element of inaccuracy into the composite variance ratios if they are averages of a diverse assortment of price variances. In the accompanying illustration two Raw Materials accounts are used. Since prices of Materials M-2 and M-3 fluctuate together they are combined and M-1 is given a separate account. The respective over-all ratios can thus be applied to the basic standard cost of materials issued to give the actual cost of materials. If all three materials are combined in a single account the over-all ratio does not yield the correct actual cost for any of the materials (Fig. 13). Note that material credits computed with the composite ratio (1.09028) differ from the correct figures computed by using individual ratios for each material. Since the latter two materials have both risen 10% in price they may be combined without error.

Material	Debits			Credits		
	Actual Cost	Ratio A/S	Basic Standard Cost	Actual Cost Using Individual Ratios	Actual Cost Using Composite Ratio	Basic Standard Cost
M-1	\$ 450.00	.9444	\$ 900.00	\$ 442.00	\$ 510.75	\$ 489.00
M-2	3 450.00	1.10000	3 500.00	1 578.50	1 564.15	1 435.00
M-3	11 000.00	1.10000	10 000.00	2 370.00	2 255.00	2 100.00
Combined	\$15 700.00	1.09028	\$16 400.00	\$4 390.50	\$4 490.90	\$4 000.00

FIG. 13. Different Methods for Computing Actual from Basic Standard Costs

**WORK IN PROCESS**—Work in process accounts are kept at both actual and basic standard costs. The procedure for putting this method into effect is presented below.

**Material**—The transfer of raw materials from stores to production is recorded by debiting Work in Process and crediting Raw Materials at both actual and standard costs (entry 2). The transfer is made in two instalments:

1 The actual cost column is debited with the actual cost of materials requisitioned. This is computed by multiplying the basic standard cost of materials by the over-all ratio from the proper raw material account. The effect of this procedure is to charge Work in Process with the average actual cost of materials, but the method requires less clerical effort than does the use of average costs in cost systems not using standard costs.

2 The summary of consumption for the period is priced at standard unit direct material cost and the resulting figure is used as the basis for a second entry charging the standard cost column of Work in Process.

**Labor**—The entries (3a and 3b) for charging direct labor cost to work in process accounts are similar to those given for direct materials. Actual cost is recorded by charging the actual column of Work in Process with the actual cost of labor used as shown by the payroll records. The amount of the standard cost debit is the standard cost of the standard labor content of the product made during the period. This can be obtained by recording on labor time cards both the actual and standard times and rates for the work done or the periodical record of quantities produced can be priced at standard unit labor cost.

**Overhead**—The actual cost columns of Work in Process accounts are debited with the applied overhead cost (entry 4) that is with actual hours worked multiplied by the normal overhead rate. This is in conformity with the general practice of including only normal overhead in the so-called actual cost of goods manufactured. The standard cost columns of departmental work in process accounts are also charged with standard hours in work produced extended at the normal overhead rate.

**Work in Process Classification**—The classification adopted for Work in Process accounts is important under this method of keeping the accounts for, as with raw materials accounts, it is essential that the significance of figures be not destroyed by inappropriate averaging. Where each work in process account represents only a single product and manufacturing operations are few no serious difficulty arises but when a great many different articles are being made and the processes through which they pass are numerous and varied some grouping of products and operation costs under a single Work in Process account becomes necessary to avoid excessive clerical expense. Under these circumstances, the application of the variance ratio from the debit side of the account to compute other variance ratios and actual cost of goods finished may, if the over all average is not homogeneous yield results having no useful interpretation. In addition when products are so grouped under one Work in Process account it is impossible to obtain the actual cost variance applicable to any single product in the group. One steel mill, however, using the dual method reports that it has 40 product classes. This grouping represents a compromise between complete accuracy and reasonable clerical costs. The problem is no simpler with other types of standard cost plans in fact the latter often make no attempt to assign variances to a particular product because of clerical complications. In reality this is a strong feature of the dual plan.

For the maintenance of adequate cost control any significant change in cost must noticeably influence the cost ratios which are relied upon as guides to the effectiveness of current performance. It must be possible to trace such variances down to their underlying causes with as much facility as possible. The degree of sensitivity toward cost changes that variance ratios possess depends principally upon the classification of products and processes under work in process accounts. By altering this classification, it becomes possible to emphasize or to minimize any particular class of cost fluctuation according to the importance a knowledge of such variances is expected to possess. For example if experience shows a product is subject to rather large material and labor usage variations but the small volume in which the product is made causes these inefficiencies to be not worth the trouble needed to prevent them the product can be grouped with other similar products. So long as the cost

ratio for the group is maintained at its proper level the management need not be concerned with it but when any variation or combination of variations becomes large enough to affect the group ratio, managerial attention becomes necessary in order to protect the profit margin on the product group. On the other hand if positive control of individual product costs is desired separate work in process accounts for each product must be kept, in order that needed variance ratios may be computed.

The same steel mill cited above reports that cost control is exercised departmentally and the information is available to whatever degree required. The analysis of variances is available by lines and by departments as shown below.

Product Line	Total Ratio	Departments			
		A	B	C	Etc
1	98	102	104	92	
2	102	105	101	102	
3	104	101	104	100	
etc					

For cost purposes, however such variances merge, properly weighted into the inventory accounts and so are prorated to sales.

**FINISHED GOODS TRANSFER**—Through entry 6 finished goods are credited to work in process accounts at both actual cost and basic standard cost. The actual cost of the goods finished is calculated by multiplying the basic standard cost of the number of units completed by the over-all cost ratio standing in the Work in Process account. The resulting 'actual' cost is thus an average cost of all lots of goods worked on during the period rather than a specific job cost. If the goods are transferred to another work in process account both actual and standard costs of the completed work are entered in the appropriate columns of the next account.

When the cost of production is transferred to the Finished Goods account (entry 6) the latter is debited at actual and standard. The same scheme may be employed when recording the cost of shipments by crediting Finished Goods and debiting Cost of Sales at actual and standard. However, according to the method developed by Cramton (Basic Standard Costs) Cost of Sales is debited only at actual cost the standard cost being closed into Standard Cost Clearing account (entry 7b). Some accountants go so far as to stop the dual costing when transferring from Work in Process to Finished Goods by closing the standard cost into Standard Cost Clearing on the theory that there is no longer any need for standard costs as a measure of manufacturing efficiency. Finished goods are thus carried at average actual cost.

**DEPARTMENTAL EXPENSE ACCOUNTS**—Actual expenditures and accruals for overhead are debited to departmental expense accounts (entry 5). Service department costs are distributed to producing departments the distributed amounts applicable to each producing department being entered in the actual cost column of the overhead account. Note that the power cost debits received by the two producing departments differ under the dual plan as compared with the partial and single plans for with the dual plan the actual cost of power production during the month is allocated whereas under the other two methods only the budgeted cost is charged to the producing departments.

The figures for distributing the total power charge are derived as follows

	Dept A	Dept B
Fixed charges on capacity basis (%)	\$ 187 50	\$ 562 50
Variable charges on consumption basis		
Variable Charges = Wh consumed		
$\frac{\$687\ 50}{90\ 000} = \$0076389$	25 000 l wh 190 97 <u>\$ 378 47</u>	65 000 l wh 496 53 <u>\$1 059 03</u>

Unabsorbed actual overhead balances are closed to Profit and Loss in entry 8. If preferred these overhead balances may be deferred or they can be distributed to inventories and cost of sales for the use of basic standard costs need not alter the company's practice in this respect.

**LEDGER ACCOUNTS AND STATEMENTS**—The completed accounts are shown in Fig 14. The profit and loss statement and balance sheet are shown below.

### PROFIT AND LOSS STATEMENT

MONTH OF JUNE 19—

Sales		\$ 8 750 00
Cost of Sales (Schedule 1)	\$ 5 930 00	
Add Net Underapplied Expense	<u>459 50</u>	6 388 50
Gross Profit		<u>\$ 2 361 50</u>

### COST OF SALES

(Schedule 1)

Materials Purchases	\$15 700 00	
Less Inventory at end	<u>11 303 50</u>	\$ 4 396 50
Direct Labor		1 951 50
Manufacturing Expense (normal)		4 435 00
Current Manufacturing Charges		<u>\$10 783 00</u>
Less Work in Process Inventory at end		1 295 00
Cost of Production		\$ 9 488 00
Less Finished Goods Inventory at end		<u>3 558 00</u>
Cost of Sales		<u>\$ 5 930 00</u>

### BALANCE SHEET JUNE 30 19—

Assets		
Accounts Receivable	\$ 8 750 00	
Raw Materials Inventory	11 303 50	
Work in Process Inventory	1 295 00	
Finished Goods Inventory	<u>3 558 00</u>	
Total Assets		<u>\$24 906 50</u>
Equities		
Vouchers Payable	\$20 593 50	
Accrued Payroll	1 951 50	
Net Profit from Manufacturing	<u>2 361 50</u>	
Total Equities		<u>\$24 906 50</u>

## RAW MATERIAL M-1

	Actual	A/S	Standard		Actual	A/S	Standard
(1a)	\$ 860 00	91444	(1a) \$ 900 00	(2a)	\$ 432 00	94444	(2a) \$ 408 00
				Bal	408 00	94444	432 00
	<u>\$ 860 00</u>	<u>91444</u>	<u>\$ 900 00</u>		<u>\$ 840 00</u>	<u>94444</u>	<u>\$ 900 00</u>
Bal	\$ 408 00	91444	\$ 432 00				

## RAW MATERIALS M-2 AND M-3

	Actual	A/S	Standard		Actual	A/S	Standard
(1b)	\$14 850 00	1 10000	(1b) \$13 500 00	(2a)	\$ 3 954 50	1 10000	(2a) \$ 3 595 00
				Bal	10 805 50	1 10000	9 905 00
	<u>\$14 850 00</u>	<u>1 10000</u>	<u>\$13 500 00</u>		<u>\$14 850 00</u>	<u>1 10000</u>	<u>\$13 500 00</u>
Bal	\$10 805 50	1 10000	\$ 9 905 00				

## WORK IN PROCESS—DEPARTMENT A

	Actual	A/S	Standard		Actual	A/S	Standard
(2a)	\$ 2 070 50	1 09916	(2b) \$ 1 950 00	(0a)	\$ 5 349 00	1 11438	(5a) \$ 4 800 00
(3a)	1 263 00	1 33520	(3b) 950 00				
(4)	2 064 00	1 03750	(4) 2 000 00				
	<u>\$ 5 349 00</u>	<u>1 11438</u>	<u>\$ 4 800 00</u>		<u>\$ 5 349 00</u>	<u>1 11438</u>	<u>\$ 4 800 00</u>

## WORK IN PROCESS—DEPARTMENT B

	Actual	A/S	Standard		Actual	A/S	Standard
(2a)	\$ 2 376 00	1 10000	(2b) \$ 2 100 00	(6b)	\$ 0 498 00	1 07916	\$ 8 792 00
(3a)	638 00	1 08861	(3b) 632 00	Bal	1 205 00	1 07916	1 200 00
(4)	9 370 00	98750	(4) 9 400 00				
(6a)	5 349 00	1 11438	(6a) 4 800 00				
	<u>\$10 793 00</u>	<u>1 07916</u>	<u>\$ 9 992 00</u>		<u>\$10 783 00</u>	<u>1 07916</u>	<u>\$ 9 992 00</u>
Bal	\$ 1 793 00	1 07916	\$ 1 200 00				

## FINISHED GOODS

	Actual	A/S	Standard		Actual	A/S	Standard
(6b)	\$ 8 488 00	1 07916	(6b) \$ 8 792 00	(7b)	\$ 5 930 00	1 07916	\$ 5 495 00
				Bal	3 558 00	1 07916	3 297 00
	<u>\$ 9 483 00</u>	<u>1 07916</u>	<u>\$ 8 792 00</u>		<u>\$ 9 488 00</u>	<u>1 07916</u>	<u>\$ 8 792 00</u>
Bal	\$ 3 558 00	1 07916	\$ 3 297 00				

FIG 14 Ledger Accounts for

## OVERHEAD COST—DEPARTMENT A

(ab)	\$ 378 47	(4)	\$ 2 065 00
(ac)	1 036 00		
(5) I L	50 53		
	<u>\$ 2 065 00</u>		<u>\$ 2 065 00</u>

Overapplied

## OVERHEAD COSTS—DEPARTMENT B

(ab)	\$ 1 670 00	(4)	\$ 2 370 00
(5c)	1 870 00	(8) P L T	509 03 *
	<u>\$ 2 570 00</u>		<u>\$ 2 570 00</u>

\* Underapplied

## VOUCHERS PAYABLE

Bal	\$20 708 00	(1)	\$ 800 00
		(1)	14 950 00
		(2c)	1 437 50
		(5c)	8 450 00
	<u>\$20 575 50</u>		<u>\$20 593 50</u>
		Bal	\$20 593 50

## COST OF SALES

(7)	<u>\$ 5 930 00</u>	(8)	<u>\$ 5 930 00</u>
-----	--------------------	-----	--------------------

## SALES

(8) I & L	<u>\$ 8 750 00</u>	(9)	<u>\$ 8 750 00</u>
-----------	--------------------	-----	--------------------

## ACCRUED PAYROLL

(3a)	\$ 1 951 50
------	-------------

## ACCOUNTS RECEIVABLE

(7)	\$ 8 750 00
-----	-------------

## POWER COSTS

(5a)	<u>\$ 1 437 50</u>	(5b)	<u>\$ 1 437 50</u>
------	--------------------	------	--------------------

## PROFIT AND LOSS

(8)	\$ 2 361 50
-----	-------------

## STANDARD COST CLEARING

(2a)	\$ 4 000 00	(1a)	\$ 000 00
(7b)	5 400 00	(1b)	13 500 00
Bal	14 884 00	(2b)	4 010 00
		(3b)	1 582 00
		(4)	4 400 00
	<u>\$24 392 00</u>		<u>\$24 392 00</u>
		Bal	\$14 834 00

Dual Plan Standard Costs



**VARIANCES UNDER DUAL PLAN**—Where basic standards are used two characteristics appear in connection with variances from standards

- 1 The variances are not incorporated in the bookkeeping records but are derived statistically from information contained in the accounts
- 2 The variances are expressed as ratios of actual to standard costs. If desired these ratios can be translated into dollar amounts

**Material Usage Ratio**—Material usage ratios are computed by dividing the standard cost of the standard quantities into the standard cost of the actual quantities used. Carrying out the calculations the following results are obtained

Usage Variance Ratios	Calculation	Variance Amounts
Material M-1 $\frac{\$468}{\$450} = 1.040$	$\$450 - \$468$ $0.04 \times 450$	$\left. \begin{array}{l} \\ \end{array} \right\} \$18 \text{ loss}$
Material M-2 $\frac{\$1,435}{\$1,400} = 1.025$	$\$1,400 - \$1,435$ $0.025 \times 1,400$	$\left. \begin{array}{l} \\ \end{array} \right\} \$35 \text{ loss}$
Material M-3 $\frac{\$2,160}{\$2,160} = 1.000$	$\$2,160 - \$2,160$	$= 0$

Since basic standard usages and current standard usages are identical in this case these ratios also represent performance in terms of current standards

**Alternative Method for Computing Ratios**—The same ratios may be computed differently

- 1 Compute over all ratio. This is found by dividing the actual quantities at actual cost by the standard quantities at standard cost
- 2 Compute price ratio if it is not already available. It is found by dividing the actual by the standard unit cost
- 3 Compute usage ratio by dividing the over all ratio by the price ratio. The over all ratio may be expressed as a function of its component ratios—

$$\text{Price ratio} \times \text{Usage ratio} = \text{Over all ratio}$$

Hence if any two ratios are known the third may be found. Where the over-all and price ratios are known the above equation is easily transformed

$$\text{Usage ratio} = \frac{\text{Over all ratio}}{\text{Price ratio}}$$

The method works out as shown in Fig. 15. It is at times more convenient than the other

(1) Operation	(2) Basic Stand ard Rates (Fig 12)	(3) Actual Rates*	(4) Actual Hours*	(5) Ratio (3) ÷ (2)	(6) Percentage Variance (5) - 100%	(7) Actual Hours at Standard Rates (4) × (2)	(8) Dollar Variance (6) × (7)
1	\$ 40	\$ 50	525	1 25	25%	210 00	\$ 52 50
2	50	65	1 540	1 30	30	770 00	231 00
3	65	80	230	1 23	23	149 50	34 35
4	85	90	560	1 06	6	476 00	28 56

\* See statement of transactions page 228

FIG 16 Ratios and Variances Based on Actual and Basic Standard Rates

	M-1	M-2	M-3
1 Overall Ratio			
Actual quantity $\times$ Actual price	520 $\times$ 95	205 $\times$ 7 70	1 080 $\times$ 2 20
Standard quantity $\times$ Standard price	500 $\times$ 90 = 98 222	200 $\times$ 7 00 = 112 75	1 080 $\times$ 2 00 = 110
2 Price Ratio			
Already calculated	94 444	110 00	110
3 Usage Ratio			
(1) - (2)	104 000	102 50	100

FIG 15 Calculation of Material Variance Ratios

**Labor Rate Ratios**—Two sets of labor rate ratios may be determined. They are:

- 1 The ratios of actual rates paid to basic standard rates
- 2 The ratios of actual rates paid to current standard rates

The ratios of actual to basic standard rates show the percentage deviation of actual labor rates from basic standard rates. By comparing these ratios over a period of time the trend of actual labor rates relative to basic standard rates may be observed. In effect these ratios are index numbers of labor rates computed on a fixed base. Thus emphasis upon relative changes rather than absolute amounts of change is characteristic of the dual plan. These ratios do not serve as measures of operating efficiency, for the basic standard rates may be considerably above or below rates which represent currently attainable good performances. The calculation of these variance ratios and their translation into dollar amounts are shown in Fig 16.

Another labor ratio obtained is the ratio of actual rates to current standard rates. Under the dual plan, current standards are set primarily as percentages of basic standards. Thus the current standard labor rates given in Fig 1 would be expressed as shown in Fig 17 (col 4).

(1) Operation	(2) Basic Standard Rates (Fig 12)	(3) Current Standard Rates (Fig 1)	(4) Ratio of Current to Basic (3) - (2)
1	\$ 40	\$ 50	1 25
2	50	60	1 20
3	65	75	1 15
4	85	95	1 12

FIG 17 Ratios of Current to Basic Standard Rates

The rates given show that the labor rate which has been set as the current standard on Operation 1 is 25% above the basic standard rate. Since the extent to which actual rates paid are kept in line with current standard rates is an important aspect of plant operating efficiency, a set of ratios must be prepared for this purpose. These ratios can be cal-

culated directly by dividing actual rates by current standard rates where both figures are expressed in dollars or by dividing the ratios found in Fig 16 by the corresponding ratios in Fig 17. The latter method is generally employed since the two ratios needed are already available when the dual plan is used. Mathematically the formula is as follows:

$$\begin{aligned}
 & \frac{\text{Actual rate}}{\text{Basic standard rate}} \div \frac{\text{Current standard rate}}{\text{Basic standard rate}} \\
 = & \frac{\text{Actual rate}}{\text{Basic standard rate}} \times \frac{\text{Basic standard rate}}{\text{Current standard rate}} \\
 = & \frac{\text{Actual rate}}{\text{Current standard rate}}
 \end{aligned}$$

Detailed calculations are shown in Fig 18

(1) Operation	(2) Ratio of Actual Rate to Basic Standard Rate (Fig 16)	(3) Ratio of Current Standard Rate to Basic Standard Rate (Fig 17)	(4) Ratio of Actual Rate to Current Standard Rate (2) - (3)
1	1.25	1.25	1.00
2	1.30	1.20	1.08
3	1.23	1.15	1.07
4	1.08	1.12	.95

FIG 18 Ratio of Actual to Current Standard Rates

This latter ratio provides a measure of performance relative to an attainable standard. It is thus an indication which tells management when and by what percentage labor rates paid have deviated from the rates which were actually expected when current standards were set.

**Labor Usage Ratios**—Since labor usage ratios are calculated in the same manner as labor rate ratios, a detailed explanation is omitted and the calculations summarized in Fig 19. The ratios are shown in the last three columns of the figure. The column headings are as follows:

- A/B = Ratio of actual to basic standard
- C/B = Ratio of current to basic standard
- A/C = Ratio of actual to current standard

The last named ratio is of course obtained by dividing the first by the second. After these ratios are obtained it is possible to translate them into dollar amounts by obtaining the percentage variation (i.e. the ratio minus 100%) and multiplying the variation by the total basic or total current standard cost as required.

**Overhead Expense Ratio**—The overhead expense ratio is computed by dividing the actual overhead by the budgeted overhead cost at the actual activity level measured in labor hours. This ratio provides a comparison between actual spending and budgeted allowances and for this reason is often referred to as the spending rate or spending ratio. In the illustration (page 375) Department A has spent approximately 99% of its allowance for the number of hours operated while Department B has spent 103% of its allowance.

Operation	Standard Hours Per Unit		Units Produced	Total Standard Hours		Actual Hours	Ratios		
	Basic (Fig 12)	Current		Basic	Current		A/B	C/B	A/C
1	5	5	100	500	500	525	1 05	1 00	1 05
2	15	15	100	1 500	1 500	1 500	1 00	1 00	1 00
3	3	3	80	240	240	230	98	1 00	98
4	7	7	80	560	560	560	1 00	1 00	1 00

FIG 19 Labor Usage Ratios

The actual overhead in column (1) is obtained from the debits in the departmental burden accounts. Column (2) is the budgeted amount for the number of hours operated. It is found by interpolation in the flexible budget (Figs 3 and 4)

Department	(1) Actual Overhead	(2) Allowed Overhead (for hours worked)	(3) Expense Ratio (1) — (2)	Expense Variance (2) — (1)
A	\$2 014 47	\$2 032 50	99113	+ \$18 03
B	2 800 03	2 705 75	1 02907	— 94 28

**Overhead Efficiency Ratio**—The overhead efficiency ratio is computed from the following formula

$$\frac{\text{Allowed hours for actual production} \times \text{hourly rate}}{\text{Actual hours worked} \times \text{Hourly rate}} = \frac{\text{Allowed cost (for units produced)}}{\text{Standard cost in product}}$$

The hourly rate referred to is the basic standard burden rate and it could therefore be dropped from both top and bottom of the fraction. However in the form shown above, the products in the numerator and denominator are already present in the Work in Process accounts. Thus the numerator represents the overhead debit in the standard column of the account and the denominator the debit in the actual column. The account also gives the ratio of actual to standard, but what is wanted according to the above formula is the ratio of standard to actual. Hence the quickest way to get the efficiency ratio is to take the reciprocal of the ratio shown in the Work in Process account (Fig 14). Such reciprocals are easily obtained from a convenient Table of Reciprocals (see Section 25). By basing the calculation on the amount rather than on the hours the dollar variance can be calculated at once.

Department	(1) Allowed Cost (for units produced)	(2) Standard Cost in Product	(3) Ratio (Fig 14)	(4) Reciprocal of col (3)	(5) Variance Rate Col (4) — 100%	(6) Dollar Variance Col (5) × (2)
A	\$2 000 00	\$2 005 00	1 03250	96851	93149	— \$5 00
B	2 600 00	2 370 00	99750	1 01200	91200	+ 230 00

Overhead efficiency ratios provide a comparison between the standard direct labor hours and the direct labor hours actually used. The above ratios show that Department A has exceeded the basic standard hours by 3.25% while Department B has used 1.266% less than the basic standard allowance.

**Overhead Utilization Ratio**—The overhead utilization ratio, also called the capacity ratio and volume ratio, is computed by the following formula:

$$\frac{\text{Standard cost in product}}{\text{Budgeted overhead cost}}$$

The tabulation below shows the method of computation and the variances.

Department	(1) Standard Cost in Product	(2) Budgeted Overhead (for hours worked)	(3) Ratio (1) ÷ (2)	Variance (1) - (2)
A	\$7 005 00	\$2 037 50	1 01590	+ \$32 50
B	2 370 00	2 705 25	84787	- 495 25

The above table indicates for Department A a small variance gain because, expressed in hours, it operated at slightly over normal capacity. Department B shows a substantial unfavorable variance because of operations below normal capacity. (For other methods of computing overhead variances see Section 2.)

**DUAL PLAN AS USED IN PRACTICE**—The accounting procedure outlined below for a steel mill is described by Hanley (N.A.C.A. Bulletin, vol. 22)

**Establishing Standards**—Upon receipt of an order at the mill the cost clerk calculates the standard cost on the basis of the routing of the order. Standards are entered on the **standard cost card** (Fig. 20), the latter is placed in the active standard file and used to cost work on production order 64 321Z calling for 75 000 pounds of copper plated material. This material falls into product class 281 and other specifications are as indicated on the cost card. Symbol 12C440 indicates routing of the order which is as follows:

Code	Operation	Department
6110	Hot Rolling	12 Mill
6150	Pickling	12 Pickle
6303	Cold Rolling	7½ Steel Mill
6241	Plating	Plating Department
6180	Annealing	For Anneal
6242	Wiping	Wipers
6212	Sitting	Slitters
6250	Warehouse & Shipping	

The figures on the standard cost card represent standard costs for material, labor and burden per 1 000 pounds. From the company's file of standards, the cost clerk prepares the cost card showing:

- 1 The material cost at each operation during which the material cost changes
- 2 The cumulative material cost
- 3 The labor and burden for each operation
- 4 The labor and burden accumulated to the prior operation called prior labor and burden

At center 6150 some acid costing \$42 is added, bringing material cost to \$14 52 (\$14 10 + \$42). Cumulative labor and burden carried to the next process is \$5 93 (\$3 92 + \$2 01). At center 6241 22 pounds of copper plating material is added at a cost of \$3 52. This makes a total of 1 022 pounds at a cost of \$18 04 (\$14 52 + \$3 52). This is reduced to a cost per 1 000 pounds as follows:

$$18\ 04 - 1\ 022 = \$17\ 65$$

CUSTOMER THE BLANK COMPANY										ORDER NO. 64321 Z			
DEAD SOFT SETTING PASS SHEARED COILS										PROD CLASS 281 12C 440			
HR WIDTH 6 HR GA. 078 FIN WIDTH 14385 FIN GA. 014										WEIGHT 75000 #			
DATE 10/31/40													
STEEL CARBON		WEIGHT		1000 #		KIND		6 x 3 x 20					
MEMO	CENTER	SIZE	MTL	L BR	PL BR	REPL	MEMO	CENTER	SIZE	MTL	L BR	PL BR	REPL
	6110	078	\$ 14 10	\$ 3 92	\$			6242		\$	3 01	19 45	
	6150			2 01	3 92								
ACID	42		14 52					6212	15 #	17 92	4 10	22 46	
								\$ CAR LOSS				22 80	
	6303	014		7 20	5 93			6250			1 01	26 90	
	6241			5 20	13 13								
(\$ 352)	22 C		17 65		12 84							27 91	
	6180			1 41	18 04								
TOTAL							TOTAL			\$ 17 92		\$ 27 91	
Standard Cost Per H lb. ALLEGHENY LUDLUM STEEL CORP.													

Fig 20 Standard Cost Card







This is the figure shown on the standard cost card. In the same way cumulative labor and burden is reduced to an equivalent cost per 1,000 pounds

$$13.13 - 1.022 = \$12.84$$

At center 6212 where the material is slit, a definite allowance of 15 pounds for slit loss is provided. This leaves 985 pounds costing \$17.65 for material and \$22.46 for labor and burden. These figures are again converted to equivalent costs per 1,000 pounds

$$\$17.65 - 985 = \$17.92$$

$$\$22.46 - 985 = \$22.80$$

**Charging Work in Process**—Actual expenditures for a given product line, including overhead at normal rates are charged to the proper inventory account. In the case illustrated Account 281 covering high-carbon cold-rolled annealed material is used. These inventory accounts are further subdivided between labor and burden on the one hand, and material on the other.

Similar accounts are maintained at standard and are charged for the actual quantities involved at the standard costs appearing on the cost card (Fig. 20).

The cost ledger is made self-balancing by introduction of a Standard Cost Control or Clearing account.

**Material Cost Procedure**—Fig. 20 shows graphically the cost plan in question and its relation to the standard cost card. Form I shows standard and actual costs of billets and bands purchased, the entry for which is

	Actual		Standard	
(1)				
Billets and Bands Purchased	\$		\$	
Vouchers Payable		\$		
Standard Cost Control				\$
To record actual and standard cost of raw material purchased				

As material is transferred to production the following entry results

	Actual		Standard	
(2)				
Work in Process (Account 281)	\$		\$	
Billets and Bands Purchased		\$		
To transfer material consumed				\$

The standard cost is computed on the basis of the actual weight of material, acid and copper, at standard unit cost. The actual cost in entry (2) is computed from the standard on the basis of the ratio of actual to standard cost in the Raw Material account.

**Scrapped Material**—The company in question does not directly isolate scrap costs in the accounts. A certain amount of scrap is expected, and may therefore be allowed for in setting standards for material, labor, and overhead. It is possible to predetermine the theoretical slit loss since the latter is a function of the initial width of the strip and the widths that are to be made from it. Hence, the company per-

mits an allowable slit loss to remain in both the actual and standard columns of the Work in Process account. The excess slit loss is removed from the account as shown below. The following is a description of the accounting procedure for scrap.

1 Assume actual cost of material up to point of scrapping	\$1 000 00
2 Standard cost of material	1 000 00
3 20% of material is scrapped	200 00
4 Value of scrap	50 00
5 Material amounting to \$600 00 at standard is transferred to Finished Goods	

For the sake of simplicity the entries involving material are illustrated in detail. Labor and burden entries are similar except there is no credit in the Actual column for the salvage value of labor and burden.

### Journal Entries—

	Actual		Standard	
(1)				
Standard Cost Control			\$	
Labor in Process				\$
Burden in Process (Subaccount 281)				
To remove cumulative labor and burden to point of scrapping, from cost accounts (standard cost column)				
(2)				
Standard Cost Control			200 00	
Scrap Inventory	\$ 50 00			
Materials in Process (Subaccount 281)		\$ 50 00		200 00
To remove material value of scrap from cost accounts and charge scrap account for market value of scrap				
(3)				
Finished Goods	712 50		600 00	
Materials in Process (Subaccount 281)		712 50		600 00
To transfer to Finished Goods computed as follows:				
Material in Process—Actual balance \$950 00				
Material in Process—Standard balance \$800 00				
Ratio $A/S \frac{950}{800} = 118.75$				
Actual cost of transferred material \$600 00 $\times$ 118.75 = \$712 50				

By means of entry (1) the cumulative labor and overhead costs to the point of scrapping are credited to the standard cost accounts and charged to Standard Cost Control. Entry (1) removes the cost value of direct material scrapped from the standard Work in Process account but only the salvage value from the actual Work in Process account.

leaving a net loss resulting from the scrap in the actual Work in Process account. In the case of labor and burden, the actual cost of all labor is left in the actual Work in Process accounts and only the standard cost of the good units in the standard labor and burden accounts. The ratio of actual to standard cost in Work in Process is increased as a result of the entries indicating the presence of unallowable scrap. The effect of this procedure is to prorate the scrap losses over the good pieces produced.

**Labor Cost Procedure**—Payroll figures are analyzed departmentally according to direct and indirect labor (Fig. 21 form H). Direct labor is also distributed to product classes on the basis of the relative amounts of standard labor costs for individual lines within a product group, and summarized by lines for all departments (Fig. 21 form D).

Indirect labor is charged to a burden account (Fig. 21 form G). Summary entries for labor are as follows:

	Actual		Standard	
(3a)				
Work in Process (Account 281)	\$		\$	
Vouchers Payable or General Ledger		\$		\$
Standard Cost Control				
To summarize direct labor costs				
(3b)				
Actual Burden				
Vouchers Payable or General Ledger				
To summarize indirect labor charged to standing orders				

**Burden Cost Procedure**—Actual overhead other than indirect labor is collected from the actual sources (Fig. 21, form G) and charged to the Actual Burden account. Overhead applied to product is calculated departmentally by multiplying the actual man or machine hours by the normal burden rate (Fig. 21 form J). It is then analyzed in the same way as labor:

- By departments showing product lines in each department (Fig. 21 form C)
- By product classes with departmental breakdown (Fig. 21 form D)

Summary entry for burden is as follows:

	Actual		Standard	
(4)				
Work in Process	\$		\$	
Absorbed Burden		\$		\$
Standard Cost Control				
To charge Work in Process for actual and standard burden				

Burden amounts for entry (4) are calculated as follows:

$$\text{Actual burden} = \text{Actual hours} \times \text{Normal rate}$$

$$\text{Standard burden} = \text{Standard hours} \times \text{Normal rate}$$

**Cost Procedure for Variances**—Difference between actual and absorbed burden is closed to Profit and Loss (Fig 21, form G) Entries are as follows

	Actual		Standard	
(5)				
Burden Absorbed	\$			
Actual Burden		\$		
To close				
(6)				
Profit and Loss				
Actual Burden				
To close balance representing unabsorbed overhead in latter account				

In addition the following are prepared

- a A weight loss on each item is computed at standard material cost and cumulative labor and burden cost (Fig. 21 forms B and D)
- b Standard slit loss is computed and variations from standard determined in dollars (Fig. 21 forms B and D) If there is recovery in connection with the slit loss the entry for the set-up value is made in the standard column crediting Inventory

Entry is as follows

	Actual		Standard	
(7)				
Standard Cost Control			\$	
Work in Process (Subaccount 281)				\$
To charge former account and receive Work in Process of standard values of weight loss and slit loss variance. Values include standard material also standard labor and burden				

**Costing Finished Production**—From the production records and the standard cost card the standard value of completed production is determined. The actual cost is found by applying the ratio of actual to standard costs in the Work in Process account. The entry follows

	Actual		Standard	
(8)				
Cost of Sales	\$		\$	
Work in Process (Subaccount 281)		\$		\$
To record actual and standard costs of finished production shipped to customer				

**Periodic Reports**—Reports at the plant in question are issued fortnightly and cover

- 1 Productive Labor Report (Fig 22)
- 2 Monthly Material Loss Report (Fig. 23)
- 3 Monthly Report on Gross Profit by classes of product (Fig 24)

ALLEGHENY LUDLUM STEEL CORPORATION							
WEST LEECHBURG DIVISION							
PRODUCTIVE LABOR REPORT				PERIOD NOV 17 30 1940			
CENTER	DEPARTMENT AND PRODUCT GROUP	ACTUAL	STANDARD	RATIO	VARIATION		
					TOTAL	TIME	RATES
600	9 HOT MILL						
	CARBON	\$ 0.000	\$ 0.000	000	\$ 0.00	\$ 0.00	\$ 0.00
610	12 HOT MILL						
	CARBON	0.000	0.000	00	0.00	0.00	0.000
	SILICON	0.000	0.000	00	00	00	0
	CHROME	0.000	0.000	000	000	00	000
		0.000			000	000	00

FIG 22 Productive Labor Report

ALLEGHENY LUDLUM STEEL CORPORATION							
WEST LEECHBURG DIVISION							
MATERIAL LOSSES				MONTH OF NOVEMBER 1940			
CENTER	DEPARTMENT AND PRODUCT GROUP	POUNDS LOST	YIELD %	LOSSES IN DOLLARS			
				MATERIAL	PRICE LAG & BURDEN	TOTAL	RECOVERED NET LOSS
600	9 HOT MILL						
	CARBON STEEL	00,000	0000	\$ 0.000		\$ 0.000	\$ 0.000 \$ 0.000
610	12 HOT MILL						
	CARBON STEEL	0.000	0000	000		000	000 000
	SILICON	000	0000			000	000 000

FIG 23 Material Loss Report

ALLEGHENY LUDLUM STEEL CORPORATION							
WEST LEECHBURG DIVISION							
GROSS PROFIT BY CLASSES OF PRODUCT				MONTH OF NOVEMBER, 1940			
CLASS	PRODUCT	NET SALES		1 PRICE PER 1000	GROSS PROFIT		
		POUNDS	DOLLARS		DOLLARS	%	10
231	PLAIN H.R. LOW CAR STRIP	0.000 000	000, 0.00	00 00	00.000	0.0	
232	HIGH CAR.	0.000 000	000 0.00	00 00	0.000	0.0	
241	P & O LOW CAR STRIP	000 000	00 0.00	00 00	0.000	0.0	
47	HIGH CAR.	00 000	0.000	00 00	000	0.0	
243						0.0	

FIG 24 Report on Gross Profit by Classes of Product

### Comparison of Standard Cost-Keeping Methods

**GENERAL REQUIREMENTS FOR COST SYSTEM**—Any cost accounting method must provide management with cost information needed to operate the business intelligently and efficiently. Closely linked with this first requirement is that of economy in operation for costs should be not only obtainable, but obtainable with a minimum

expenditure of money and effort. Any practical system is necessarily a compromise between these two requirements because additions to the amount and accuracy of cost data to be provided entail more expense. The limit at which expansion should stop is the point where costs exceed the benefits returned for the expenditure. Consideration must also be given to preferences and limitations of executives who are to use cost data, for the accountant's reports must be in a form which executives are able and willing to use in the management of the business.

Where optional methods are available for accruing costs, the accountant must choose the one which gives the optimum balance between utility to management and expense of operation.

**LIMITATIONS OF PARTIAL PLAN**—Under this method Work in Process is charged at actual and credited at standard cost. Where the work to be costed comprises only a few simple operations, where clerical work must be kept at a minimum and where frequent detailed analyses of variances from standard are not desired the partial plan is serviceable. Nevertheless, it has distinct shortcomings when the preceding conditions do not obtain. These are:

1. **Variances** are not revealed until the end of the accounting period and after an inventory of work in process has been taken. It is then too late to avoid losses that have occurred by reason of waste or inefficiency in the factory. Strong and positive control of operations to insure that standards are met requires immediate rather than delayed reports on variances.

2. Separation of total cost variance into its elements requires the collection of additional statistics not available from the accounting records. These may not be readily available, and expense must be incurred to keep and summarize them. Hence variances are not developed automatically as part of the bookkeeping routine, nor does the method always provide material from which to compute them.

These limitations are doubtless responsible for the infrequent application of this method.

**LIMITATIONS OF SINGLE PLAN**—Because Work in Process is charged and credited at standard, this method has as its principal advantages, promptness with which variances from standard costs are disclosed, simplicity and economy with which accounts are operated, and the ability to provide analysis of variances in as much detail as the management may desire. It is based primarily upon the theory that standard costs are real costs suitable for inclusion in the financial statements. It is, however, possible to close the variance accounts into Cost of Sales and inventories for the purpose of stating these items at actual cost, although distribution of variance balances is apt to be a rather rough estimate. There is, however, no serious objection because of the fact that variances are not attached to particular units of goods whose manufacture has caused them to arise. The method of variance disposal does not, of course, affect the detailed assignment of responsibility for variances before the goods reach the finished stage. It is for the above reasons that this plan with modifications to meet individual plant requirements, is probably the most common.

A more serious criticism of this method comes from a steel manufacturer using the dual plan. According to this source it is practically



impossible to allocate variances to product classes under the single plan with any accuracy. Furthermore unless the standards are extremely accurate and are continuously revised, the cost of the product is meaningless. The single plan gives control information but the cost information is not particularly useful. This is especially the case of one company which finds itself in difficulty in the preparation of cancellation charges against government contracts, because of its inability to apply variances to the costs of particular products.

**LIMITATIONS OF DUAL PLAN**—The dual plan provides essentially the same information as the single plan, but has as its principal feature the use of percentages rather than amounts. Thus it relies upon mathematical processes of division and multiplication rather than upon addition and subtraction as do the other methods. In comparison with the single plan, it is not so effective in providing variance data with promptness because it is necessary to have entries made in the accounts and the ratios computed before actual performance can be compared with standards. In contrast with the single plan, the dual plan is based upon the theory that only actual costs should be carried into the financial statements and standard costs are accordingly cleared from the books as soon as they have served their purpose as aids to control of manufacturing operations.

The main advantages obtainable with the dual plan are

- 1 Through use of basic standards which remain unchanged it is possible to **measure trends** in performance over a considerable period. This enables management to observe tendencies in the price of materials and labor, to determine what progress is being made in reducing the physical usage of cost elements by eliminating waste and improving performance and to compare such trends in cost with trends in market price of the company's products in order to see whether the spread (or gross profit) is increasing, decreasing or remaining constant. Maintenance of a proper balance between rates of change in these variables is often more important to management than amounts spent and taken in. Hence to management a technique which expresses these data as ratios to a fixed basis may have distinct value. In addition management is provided with a long range historical picture of operations which helps explain why profits or losses have been sustained. When the direction and rates of change in such variables are known it is possible to project them into the future to aid the planning of future operations. Information of this type is not so readily obtained from accounting methods which use current rather than basic standards.

- 2 This method emphasizes the advantages which relative figures have over absolute figures, since it computes variances in percentage form. Management is thus enabled to judge the degree of variation from a fixed standard.

- 3 The same source mentioned above also maintains that the dual plan reveals by product lines at least as much detail or more concerning actual and standard costs as the single plan. It is just as effective in providing control data as information provided by the other plans since such information comes from the same source with the same frequency. The real advantage of the dual plan is not so much the use of basic standards as it is the method of prorating variances handling scrap losses etc. with a minimum of clerical work. It provides both adequate

control data and cost information in contrast to the other methods which while furnishing the adequate control data yield less satisfactory cost information.

The dual plan also has certain **disadvantages** which, under some conditions are serious enough to make it undesirable. These are:

1 It is more complex and thus more difficult to understand than the other two methods. Even though the accountant may be thoroughly familiar with the method he may find it a hard task to explain to an executive how his cost figures were derived. To a lesser extent this is true of all standard cost plans.

2 While much labor can be saved by grouping items and computing such individual costs as may be desired by applying ratios to basic standards, the real details are sacrificed in the process of averaging which produces the ratios. Much care must be used in designing the system to avoid obscuring important differences in cost and emphasizing others of small consequence. In order to preserve these details a sufficiently large number of accounts must be carried in the factory ledger. Here again it is a question of the amount of detail desired. Every detail is available for control if desired but some grouping must be done under any plan to condense the voluminous data into some intelligible form. Thus one manufacturer under the dual plan accumulates departmental data by product classes for each payroll period. It is then summarized by classes for the month. Only one set of entries is then made. Cost of Sales for the month previously priced at standard is adjusted in the monthly summary. This plan has proved a real work saver.

3 The dual plan may involve more clerical work than the single plan because parallel entries at both standard and actual cost must be made. The work added by this latter feature may, under favorable conditions be offset by grouping items into a few accounts and computing actual costs with the aid of ratios developed in these accounts.

4 Since comparisons with basic standards do not provide good measures of efficiency it is necessary to use a second set of standards representing current performance. This double set of standards, each of which has a different meaning, may be confusing to those who use the figures and also involves a certain amount of additional work in setting the standards. Furthermore, it is possible that current standards may be unscientific estimates if the company feels that the problem of setting standards has been solved when basic standards are set. Basic standards are merely convenient reference points from which to measure subsequent changes and current standards are really the ones used to maintain control of costs. For this reason it is much more important to have current standards scientifically set than it is to have basic standards established with precision.

At times this may be an unfair criticism of the dual plan. Basic standards are changed from time to time when necessary. They do not, however, require frequent changing. The latter is the occasion for considerable work under other plans. Hence because of the relative infrequency of revisions of standards under the dual plan, the work is more apt to be done carefully.



## SECTION 8

### SPECIFIC ORDER COST SYSTEMS

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## SECTION 8

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### SPECIFIC ORDER COST SYSTEMS

#### Job Order Production Control

**JOB ORDER SYSTEM**—The ability to segregate or identify quantities of product going through the plant at any time is a chief prerequisite of job or **specific order costs**. Therefore a job order system is one which collects separately each element of cost for each job or order worked on by the plant. This type of cost system is found in companies doing special work or manufacturing to order. Contractors, custom tailors, shipbuilders, machine shops, foundries, ornamental metal work serve as illustrations. Companies producing a wide variety of products such as toilet preparations, welded boilers of many sizes, bolts and nuts and furniture use job order cost accounting systems because the products are produced in lots. According to Van Sickle (*Cost Accounting*) there are three groups using the job order cost plan.

- 1 In the manufacturing group the job order cost plan is used in such industries as the manufacture of castings, machine shop products, heavy machine tools, heavy electrical apparatus, locomotives and other rolling stock, gears and pinions, job printing, clothing, furniture, boats and barges.
- 2 Construction concerns use job order cost systems to ascertain the general cost of buildings and the subcontractors' cost of electric wiring, plumbing, flooring, roofing, etc. The job order cost plan is also used to ascertain the cost of bridges, viaducts, dams and roads.
- 3 Public utilities use the job order cost plan to arrive at the cost of extension developments and other capital projects.

To this list should be added the case of such plants which, though employing some other cost system for costing their products, use job order costs for a variety of purposes. These include special repair orders, research and development work, improvement and betterment orders, new machine installations, etc. The production of motion pictures falls in the class of job order costing since each picture is a unique venture and costs and profit must be determined for each picture.

**Characteristics and Purposes**—From the point of view of production, job order costs are based on specific identification of the product and the ability to follow such product through the plant from the raw material to the finished stage. Manufacture is initiated by receipt of a customer's order or in case of internal orders, issuance of an order for special work. From the viewpoint of accounting costs are determined by jobs, a job cost sheet being set up for each job as soon as the order is issued.

The purpose of job order costing is stated by Reitel and Johnston (Cost Accounting)

Securement of costs applicable to an order makes possible a comparison between the selling price and the cost. From the comparison it can be ascertained whether or not the price quoted the customer was too low and whether or not the cost element expenses were too high. Again a record of each completed job order is filed away with a description of the commodity produced. This record will be of assistance in quoting prices to prospective customers on new or similar orders in the future. Prices on future customers' orders can be quoted more intelligently when there is a record showing the cost of like or similar orders previously manufactured.

**Advantages and Disadvantages**—The advantages of job order costing may be summarized as

- 1 Ability to detect which jobs are profitable which unprofitable
- 2 Use of job costs as a basis for estimating similar work in the future
- 3 Use of job costs as a basis for controlling efficiency of operations. This is done by comparing actual costs against estimates which are prepared when making quotations to a customer.
- 4 Use of job costs on government contracts and other contracts where cost determines selling price. In such contracts the manufacturer is allowed to charge cost plus a fixed fee or cost plus a reasonable profit. Such costs must be kept on a specific order basis.

However, it should be noted that job cost information as a basis for estimating similar work in the future can be used only within limits. There may be considerable discrepancies in the costs of production because of differences in time between the completed order and the one being estimated and also differences in the size of the order. It is possible of course that when compiled in useful form job order costs may furnish serviceable data for estimating purposes.

In general job order systems of the **actual cost type** share the disadvantages of all historical cost systems. In addition the cost of operating a job order system is considerable. The volume of detail which must be kept is large and the question often arises as to the justification for the heavy clerical expense necessary to find out what an order actually costs. On the other hand, job order costs used in connection with a **standard cost system** share the advantages of the latter type but are still open to criticism on the score of large clerical expense.

**REQUIREMENTS OF JOB ORDER SYSTEM**—Job order production requires two kinds of mechanisms for effective operation

- 1 Production control
- 2 Accounting control

The two are difficult to separate since those charged with production depend in many instances on information contained in accounting records. In turn **computation of costs** depends in part on information gathered by the production section.

Forms most characteristic of, and most commonly associated with specific order systems are

- 1 Production Order
- 2 Bill of Materials
- 3 Operations Schedule













machines or stations where work is to be done and instructions regarding the manner in which the work is to be performed. These cover

1. Speed
2. Feed
3. Set up time allowance
4. Standard time allowance

Where the work is more complex, separate instruction cards are made out for each operation showing how the work is to be performed. These accompany the operations schedule.

**Tool List**—A list of tools required, whether special or standard, is prepared and accompanies the instruction cards and operations schedule. In this way the operations schedule and tool list take care of production problems relating to labor, machines, and tools.

**Planning or Work Ahead Schedule**—A planning schedule is in effect a time table for scheduled production. As described by Moorman (NACA Bulletin vol. 13)

Its function is to display the jobs or orders in the process of production and is therefore simply a rack with suitable hooks or receptacles to hold the production order control card. Each work station at which an operator is required, whether machine bench or assembly floor, is represented on the production control board by a work station number. This is neces-

<div style="text-align: center; margin-bottom: 20px;">  </div> <div style="text-align: center;"> <h2 style="margin: 0;">Route Tag</h2> <p style="margin: 0;">for</p> <h2 style="margin: 0;">Material On</h2> </div> <p>ORDER _____</p> <p>DESCRIPTION _____</p> <p>_____</p> <p>QUANTITY _____</p> <p style="text-align: center;">MATERIAL</p> <p>KIND _____</p> <p>FOR _____</p> <p>_____</p> <p>QUANTITY _____</p> <p style="font-size: small;">THIS TAG IS ISSUED WITH A STORES 1 SUE SLIP</p>	<div style="text-align: center; margin-bottom: 20px;">  </div> <div style="text-align: center;"> <h2 style="margin: 0;">PART LOT TAG</h2> </div> <p>SYMBOL _____</p> <p>LAT No. _____</p> <p>DESCRIPTION _____</p> <p>_____</p> <p>QUANTITY IN ORDER _____</p> <p>_____</p> <p>QUANTITY IN THIS PART LOT _____</p> <p>_____</p> <p style="font-size: small;">A Tag like this must accompany each Truck or Container of Work in Process. It will be retained by the Stockkeeper as a Check on his Receipts.</p>
--	---

FIG. 6 Identification Tags

easy to secure proper functioning of the production control for effective results. The number is placed across the top so as to be easily recognized by the respective operators. To aid in the control of the jobs passing through the shop the hooks or receptacles are to be placed in three horizontal rows across the board on three divisions under each work station. This is to permit differentiation between jobs or orders being worked upon those waiting, next in turn and those that may have been held up during the progress of production for causes that so frequently happen in any shop.

This equipment should be centrally located and easily accessible to all employees on productive work and others on nonproductive work whose efforts can be controlled by the production department. The time clock or stamp should be located close at hand for immediate use.

In lieu of planning boards, various types of Gantt charts may be used. (See Section 25.)

**Move Ticket**—As work on the order progresses it is checked off on the operations schedule which frequently is used as a route sheet, showing in chronological order the steps required in its completion. Identification tags (Fig 6) as shown by Green (N A C A Bulletin vol 14) accompany each lot and when it is ready for transfer to the next department a move ticket or move order is issued. The planning board is adjusted to move the progress made.

**ACTUAL HANDLING OF ORDER**—Of the forms required in connection with an order as many as possible are made out in advance by the planning department. This relieves shop officials of much clerical work and centralizes the responsibility for getting the order ready. After the material is found available and is appositioned a move order issued by the planning or routing section releases it to the shop. The following description shows typical handling as described by Green (N A C A Bulletin vol 14).

Our routing force consists of two people—a young man whose duty it is to lay out the work ahead of the factory and to coordinate the activities of all manufacturing departments so as to produce an even flow of production and a girl who dispatches the job cards, move orders, material requisitions etc. through the works. They are seated at a table with a card filing cabinet between them. In this cabinet are found the route cards for all items which we make established as a permanent record while the route sheet applying to the particular order in question is superimposed over the permanent route card.

Near the table at which our route clerks work is situated a battery of pneumatic tubes which connect with all manufacturing centers and with focal points such as stores, general office and shipping room. Through these tubes are dispatched all job cards, route tags, set-up order, material requisitions etc. without effort and without loss of time.

By means of a planning board, Gantt charts, or balance of work sheets the work is laid out to provide each operator with at least 10 hours' work ahead. Green states:

After the work is laid out there comes the question of dispatching it. A certain operation No 9 on Job No 1705 we will say is needed to be done. The work is laid out ahead of operator John Smith who will run out of his present job in about 5 hours and will then be ready to go on operation No 9.

The route clerk then ascertains definitely that the machine listed for this operation on the route sheet will be available. Probably a set up is required for operation No. 9 so a set up order is issued to the toolroom requesting the set up of the machine for this particular operation and advising at what time including a margin of safety the machine must be ready. Toolroom records show what the set up in question consists of and the set up will proceed accordingly. At the same time the route clerk sends to the storeroom the requisitions (which have already been apportioned) for the material needed for the operation with the request to deliver the material to the machine or workplace designated. On the route sheet a space is provided for check marks indicating that the set up order and the material requisitions have been issued.

When the set up has been completed to the satisfaction of the manufacturing foreman he initials the original set up order which is sent immediately to the route clerk who checks his route sheet to indicate that the set up is complete and that the machine is ready for operation No. 9. Likewise when the material is delivered the manufacturing foreman examines it and having satisfied himself that the material agrees with the specifications on the requisition he initials the latter and it is sent immediately to the route clerk who again checks his route sheet to indicate that the material has been delivered. With tools ready and material ready the operation is ready for John Smith to work on as soon as he is available.

When John Smith finishes the job he is on he takes his job card for that job to his foreman who initials it and sends it to the route clerk. Here the job card is stamped out and the new job card for operation No. 9 on job No. 1765 is stamped in and sent to John Smith at his machine. The foreman has been advised previously by means of a duplicate job card what John Smith's next job was to be and he has already installed John on operation No. 9 without loss of any time.

The job card with which John is supplied while working on any job shows him exactly what the standard task time for the operation is as well as the piece rate at which he is to be paid.

Each foreman each day turns in a production report. This report lists every job which every operator finishes on that particular day and also shows the quantity finished in each case. These reports go direct to the route clerk who enters the quantities finished on the route sheets against the various operations. Thus discrepancies in counting show up immediately and can be investigated. Also as the quantity finished on each operation is compared with the quantity finished on the previous operation any undue spoilage is brought to attention. The information provided by the production report is of value in many ways and helps materially in controlling production.

**COUPON SYSTEM OF PRODUCTION CONTROL**—A scheme of production control by means of detachable coupons is sometimes feasible. It is used successfully in shoe manufacturing, production of cutlery, etc. The following description of the system applied to cutlery manufacture is adapted from Dolliver (N. A. C. A. Bulletin, vol. 20).

On a coupon strip (Fig. 7), each operation is listed on a separate coupon showing where it is to be performed, the rate, total earnings for producing the work in the standard batch. Special coupons are included in the strip for crediting production to the room or department performing the work. The coupon strip is the equivalent of a job order issued to the manufacturing department to produce a specified batch of knives. A control of coupon numbers issued is maintained in the production control office. The strips are produced from duplicator masters which

1/22	610	703	Forge
5719	612	715	7392 SHERWOOD 2/o
Sch 4	619	800	Chop Knife
	701	819	
1/22	Sent Out Cutlery - Finish Room		Clock No
5719	7392 SHERWOOD /o Chop		Quantity 25
Sch 4	To Coat Dept		Rate 07
			Total \$1 75
1/22	819	Inspect	Clock No
5719	7392	SHERWOOD /o Chop	Quantity 25
Sch 4	Cut	Fin Group Bonus	Rate \$ 005
	Passed	Rejected	Total \$ 1 5
1/	800	Wash	Clock No
5719	7392	SHERWOOD 2/o Chop	Quantity 25
Sch 4	Out	Fin	Rate \$ 005
			Total \$ 1 5
1/2	715	Finish Handl	Clock No
5719	739	SHERWOOD /o Chop	Quantity 5
Sch 4	Man	Fin	Rate \$ 075
			Total \$ 475
1/22	703	Ruff Bolster	Clock No
5719	7392	SHERWOOD /o Chop	Quantity 75
Sch 4	Man	Fin	Rate \$ 0
			Total \$ 80
1/22	701	Ruff Rims	Clock No
5719	739	Sd R OGD /o Chop	Quantity 5
Sch 4	Man	Fin	Rate \$ 012
			Total \$ 75
1/22	Sent Out Cutlery Forge Room		Clock No
5719	7392 SHERWOOD /o Chop		Quantity 5
Sch 4	To Coat Dept		Rate \$ 055
			Total \$1 375
1/22	619	Strike	Clock No
5719	7392	SHERWOOD /o Chop	Quantity 5
Sch 4	Forge	Room	Rate \$ 02
			Total \$ 50
1/22	612	Weld	Clock No
5719	7392	SHERWOOD 2/o Chop	Quantity 25
Sch 4	Forge	Room	Rate \$ 015
			Total \$ 375
1/22	610	Rivet	Clock No
5719	7392	SHERWOOD 2/o Chop	Quantity 25
Sch 4	Forge	Room	Rate 08
			Total \$ 50

FIG 7 Coupon Strip



have been prepared for each item in the line. Thus a permanent file of master strips is available for use at any time that a routing like that called for on the master is necessary. This coupon system, as stated by Dolliver, has the following advantages:

- 1 A knowledge that only the operations called for in the cost sheet will be performed on the knife. There is such a multiplicity of operations which could be and are performed on similar knives that it is almost impossible for supervisors, truckers or operators to carry them in their heads for all the different items.
- 2 We feel sure that the right piece prices or standards are being applied to the jobs, and the payroll clerk has merely to add up the coupons handed in by each man to compute his pay.
- 3 The number of the operators who perform each operation appears on the leader coupon so that it is possible for supervisors to check back on faulty work from the inspection points.
- 4 In determining the standard labor cost of our production for each room we merely add up the amounts shown on the production or 'sent out coupon' which is torn from the strip and sent to the cost department as the batch is sent from the manufacturing room with their operations finished.
- 5 A good follow up for production control purposes is possible inasmuch as batch numbers are checked to the records from the coupons torn off at various key stations and sent to the production office.
- 6 Extra operations and reoperations are readily apparent to the supervisor as there is no coupon provided for operations other than standard and the supervisor has to approve payment for all non standard operations. Through the use of special work tickets for these extra operations this excess cost information can be readily brought to the attention of the cost department.
- 7 Each batch is counted and checked at the various inspection points to insure that we are getting the count which we pay for on the coupons.
- 8 We feel that there is less chance for error inasmuch as the information is duplicated from a master which has been carefully checked for accuracy.

**Details of Procedure**—The same authority as above shows the detailed production and cost procedures through the use of the coupon system as follows:

- 1 From sales posted weekly to stock record cards we find that we need 50 dozen 7392 Sherwood two piece chop knives.
- 2 The stock control clerk makes out an order for 50 dozen 7392 Sherwood.
- 3 The schedule for the week is prepared, listing all orders which are to be manufactured.
- 4 The masters for the 7392 Sherwood are withdrawn from the file and two sets of coupon strips (Fig 7), calling for 25 dozen each, are run off and the master is filed for future use. Let us assume that one coupon strip starts with the riveting or assembly operation in the forge room and carries the work through to inspection in the cutlery finish room. The second coupon strip carries the batch from the inspection point through the finishing processes to the final inspection and packing. The coupon strip numbers are entered on the order to be used in follow up.
- 5 The stock control clerk posts the stock record from the order which is then filed in a visible file. Necessary deductions from process stock for handles and blades are made by the clerk at this point.

- 6 The coupon strips are sent out to the manufacturing rooms. In this case one goes to the forge room and the other to the cutlery finish room.
- 7 The trucker withdraws from physical stock the number of handles and blades called for on the order and delivers them with the coupon strips to the rivet operation. The handles and blades are riveted and the operator detaches the first coupon indicating his clock number on it and on the leader coupon and places the balance of the coupon strip in the box with the standard 25 dozen batch of knives. At the end of the day the operator turns his coupons into the office from which point they are sent to the payroll department.
- 8 The batch of work goes through successive operations up to the point of inspection.
- 9 The inspectors look over the batch and record on the coupon the number passed and the number rejected. Those rejected are returned for reoperation on a technical ticket. A 25 dozen batch of good work is made up, the second coupon strip is placed with this and the batch is sent through the successive operations in the cutlery finish room. A record of batches which passed inspection at this point is sent to the production office.
- 10 After the last operation has been performed in the cutlery finish room (similarly in the forge room) the sent out ticket is detached and sent to the cost department. These coupons are accumulated weekly and a sent out cutlery report is prepared from them by the cost department. This report forms the basis for credits to the cutlery finish room for the standard direct labor allowance on the three classifications: two piece knives, one piece knives and stubs.
- 11 The sent out coupons are posted to the order cards in the visible file and serve as a medium through which the progress of the work is followed. The totals for each item for the week are also posted to the stock record card.
- 12 After leaving the cutlery department the work goes to a central finishing unit serving all products and located physically some distance from the cutlery department. This work may or may not pass directly to the packing room depending on the immediate sales demand for the particular item and the condition and size of the packed stock in the packing stock room. The finishing unit is used as a sort of reservoir to supply the packing room stocks.
- 13 As the batch is completed through to final inspection and packing a separate report is made by the inspectors showing batch number, description, quantity passed and quantity rejected. This is sent to the production control office where an entry is made to the stock record and the entry on the follow up card is closed out.

## Job Order Accounting

**PRINCIPLES OF JOB ORDER COSTING**—Order numbers are assigned to all jobs or lots of product for which costs are to be collected. A cost sheet (Fig. 8) is prepared for each order, the cost of all materials used is charged to the order or cost sheet through material requisitions or bills of materials. All direct labor charges applicable to the job are recorded on time cards or labor tickets and summarized on the cost sheet for the job. Applied overhead charges are similarly shown. The elements of manufacturing costs are thus brought together in one place to be divided by the number of units produced to arrive at a unit cost.

A Work in Process control account of all jobs is maintained in the general ledger or the factory ledger. The cost of all work in process



The requisitions can be sorted as to departments daily and an entry made in the factory journal for the total of each day's issues. If daily entries are not made for the stores issues a summary entry is made at the close of each month. The effect upon the departmental Work in Process Inventory accounts and the Stores account is the same whether the summary of stores issued is entered in the factory journal daily or monthly.

If monthly entries are resorted to the daily summaries may be placed on a monthly summary of stores issued and a journal voucher prepared therefrom.

Work in Process—Department A	\$
Work in Process—Department P	
Stores	\$
or	
Material in Process	
Stores	

If departmental work in process accounts are used, the requisitions must be sorted by order numbers and also by departments.

**Scrap and Defective Work**—Scrap and spoilage must be credited back on the cost sheets being entered in red or else in a special space provided on the cost sheet. Repairs to product judged defective constitute part of the departmental overhead and should not ordinarily appear as a job cost. This is explained by Seeber (N. A. C. A. Bulletin vol. 18).

Each department is charged with the cost of all repairs to product. If the error is located before the goods leave the factory the foreman will make the repairs and charge this excess cost against his own department.

Goods returned by the customer are passed through our complaint department where we decide whether the product should be repaired or whether it would be cheaper to scrap and replace the lot. If the springs are to be repaired we enter a new production order and return the springs to work in process at the original cost. The foreman will repair the springs on this order number and when the job is costed we will exchange cost of sales with the original cost and charge the repair time to the departmental burden.

On the other hand Van Sickle (Cost Accounting) believes that defective work should be directly allocated to the jobs to which it applies instead of being charged to overhead. Cost required to replace the defective work is charged to the proper job order number. Cost value of scrap and reclaimed material and penalty wage deduction of the workman responsible for the spoilage are credited to the job. The following illustration is given by Van Sickle:

Direct material cost	\$10 00
Direct labor cost	15 00
Overhead cost	15 00
Total cost of defective work	\$40 00
Reclaimed material	\$5 00
Scrap material	1 00
Cost of spoilage	6 00
Spoilage wage deduction	15 00
Net cost of spoilage increasing the cost of job order	\$19 00

It is doubtful whether in practice this procedure can be rigorously enforced

**CHARGING DIRECT LABOR**—Time tickets form the basis of labor charges to the cost sheets. These tickets must be so designed as to show labor hours and the cost on each job worked on by the department. After the tickets have served their purpose in the payroll department, they are turned over to the cost department. The latter analyzes the tickets according to direct and indirect labor by operations and departments. The results of the analysis are recorded on a labor distribution sheet. Direct labor time tickets are then sorted by production order numbers and posted to cost sheets. (For detailed presentation of Payroll Accounting and Labor Costs see Sections 15 and 16, also summary appearing later in this section.)

Control over postings is obtained by accumulating daily analyses on a monthly recapitulation sheet from which a journal voucher is prepared at the end of the month. This voucher debits an appropriate Work in Process account or accounts and credits Payroll Accrued. The balance in Labor in Process must check against the total labor charges of unfinished job cost sheets.

The procedure for costing labor to jobs varies in actual practice. The following quotation is from Seeber (NAC A Bulletin vol 18):

We are using a duplicate labor ticket which folds over a carbon and which is so arranged that any employee can report six different jobs or operations within any one day. The original or top copy is used for cost purposes and the duplicate becomes our payroll record. A new ticket is started for each employee daily. Each morning the tickets for the previous day are torn apart and the duplicate is sent immediately to the payroll department where it is entered to the credit of the employee on our payroll books.

After sending the duplicate time tickets to the payroll department the timekeepers send the original to the divisional posting clerks where the cost of performing the various operations is posted to an original and duplicate cost analysis sheet.

The posting clerk will record the production department number, the operation, the employee number, machine or furnace number, the time consumed and the labor and burden cost. Our posting machines are of the flat bed type and are equipped with carbon rolls. In addition to posting to the cost analysis copies we receive a proof sheet or summary of a day's posting and this becomes the credit to the department for its day's production, the entry being debit Work in Process credit Operating Department.

These cost analysis copies remain in the live files of the divisional superintendent until the order is completed and are constantly referred to by the foremen who can tell at a glance which operations have been performed and whether the operators are meeting the estimated quantity per hour. The production department also uses these copies in checking through on their promised shipping dates.

**CHARGING MANUFACTURING OVERHEAD**—Under job order procedure, expenses are applied to production by means of expense rates. Such rates may be calculated at the end of the month on the basis of expenses actually incurred or they may be predetermined on the basis of estimated future expenses. (See Sections 19 and 20.) By using the latter method, total job costs can be ascertained within 24 to 48 hours after completion of an order, otherwise it is necessary to wait

until the end of the month for such costs. The cost clerk computes the overhead cost to be charged to the order and posts the amount to the cost sheet. In this way the total job cost is composed of actual material, actual labor, and estimated overhead costs. If only actual costs are desired the cost sheets are corrected by use of a supplementary overhead rate (see Section 19) or rates based on actual expenses incurred are employed. From a summary of such overhead amounts a journal voucher is prepared charging Work in Process and crediting an account called Applied Manufacturing Expense or Absorbed Overhead, etc.

**SPECIFIC CHARGES**—Costs often charged to a given order consist of such items which were specifically incurred for that order and whose benefits are not expected to last beyond the completion of the order. Special experimental and other engineering expenses, use of special tools, dies, etc., are legitimate charges to job costs.

All such direct charges must be evidenced by proper vouchers authorizing the charges. These are posted to the respective job cost sheets and summarized for entry in the appropriate journal.

Work in Process	\$	
Applied Expense		\$

At times it may be necessary to credit some account other than Applied Expense, such as a prepaid item, or Tool and Die account.

An example of a specific charge is given by Hatch (N A C A Bulletin, vol 9). After material, labor, and overhead have been posted to job cost sheet a die charge is applied at a flat rate per forging estimated to extinguish the cost of the dies by the time they are used up. (For specific charges on government contracts, see Section 3.)

**FREQUENCY OF POSTINGS**—Postings to job cost sheets may be made daily, weekly, monthly or whenever an order is finished. It varies even for each cost element. Factors influencing the frequency of posting depend largely on convenience and of course on the volume of postings to be made.

According to Rentell and Johnston (Cost Accounting) material requisitions are posted daily, labor time tickets daily or when the job is completed. Daily posting is gaining favor, for such figures are an aid in controlling production efficiency. Thus Gilbertson, reporting on cost accounting in motion picture production (N A C A Bulletin, vol 14), states:

All reports showing work done on the pictures are forwarded to the accounting department and all data are accumulated under the various subaccounts on a daily cost sheet. This sheet usually shows the budget or estimated cost of the picture and the actual accumulated cost to date. Copies of this cost sheet are distributed to the executives of the studio as well as the production manager.

Daily posting is also advocated by Hatch (N A C A Bulletin vol 9).

The material is posted directly to our cost card from a daily report of steel delivered to the hammer.

The direct labor expended on the job is posted from daily time cards to the proper columns on the cost card. There is a column for each operation. A comparison of the pieces reported on each operation and

posted checked with the amount of steel delivered to the job furnishes a splendid check on the accuracy of the daily time card count

Green (N A C A Bulletin vol 14) states

Each morning all job cards and production reports for the previous day having duly served their purposes in helping to control the production through the shop are turned over to the payroll clerk and from the data thus available the payroll is made up. From the payroll clerk the job cards go to the cost department where they are used to determine the labor and overhead costs. Similarly material requisitions used to control the flow of materials through production are turned over to the cost department where they are used to determine material costs of our job costs.

On the other hand, where the volume of postings is great a saving may be effected by accumulating requisitions and time tickets after sorting and filing in a jacket or envelope for summary posting to cost sheets when all such documents are in. Fig 8 represents a cost sheet designed for summary postings, as it appears on the face of the envelope. The envelope in which requisitions, time tickets and other charges are filed shows on its reverse side the information in Fig 9.

INVOICE NO _____		JOB NO _____	
DATE JOB RECEIVED _____		REMARKS	
DATE JOB FINISHED _____			
O K TO FILE _____			
ADDITIONAL BILLING			
JOB NO	RECEIVED	AMOUNT	

FIG 9 Completed Job Information on Cost Envelope

**Frequency of Overhead Postings**—Manufacturing expense is ordinarily not posted daily. It may, however, be posted whenever convenient.

- 1 Whenever an order has cleared a department or cost center
- 2 Weekly
- 3 Monthly
- 4 When order is complete and turned over to finished stock or shipping room

Ebert (Cost Accounting for Airplane Production N A C A Bulletin vol 19) states the case as follows:

Time tickets are prepared for each job and workman daily. These time tickets are gathered by the timekeeper and compared with the master

clock said to account for all time. The time tickets are then sorted by job orders for each department.

A summary of wage distribution by job orders and expense accounts is made each week showing the total labor for each order. As an overhead is figured as a percentage of direct labor, this summary also indicates the amount of overhead applied to each order. This summary is then posted to the cost sheets or expense accounts by departments.

**RESPONSIBILITY FOR COST COMPUTATIONS**—Responsibility for cost figures rests on the cost accounting department. It is charged with the duty of

1. Maintaining the necessary cost records
2. Issuing regular monthly statements
3. Issuing interim statements weekly and daily as a guide to management

Work must be subdivided so that bottlenecks in cost assembly are minimized and required reports speeded up. This is illustrated by Seeber (NACA Bulletin vol 18). The cost department is divided into three groups under the direction of the chief cost accountant.

The first group deals entirely with labor. They receive the cost copies of the duplicate labor tickets after they have been posted in the factory to job numbers, together with the proof sheet of daily postings and by means of a peg board system they charge each department with its share of the labor and credit each for the labor and burden absorbed on production. They accumulate daily the day work and piece work both male and female and then distribution of payroll must agree every day with the pay credited to the employees' accounts in the payroll department. Indirect labor is analyzed into several groups such as supervision, instruction, waiting for work, sweeping and cleaning, moving of stock, clerical, etc.

The second group I will call our cost summarizing group. When they receive the notice of final shipment they call in the cost analysis copy from the divisional factory clerks, collect partial shipment slips and requisitions for direct supplies and materials and summarize the costs which are then applied to the cost department copy of the sales invoice.

The third division is handled directly by the cost accountant and his assistant. This includes the factory journal through which all tabulations and closing entries are passed and the factory ledger.

**VALUING WORK IN PROCESS**—The value of work in process is made up of material, labor, and burden through the stage of completion reached at the closing date. Hence it consists of the sum of all charges appearing on cost sheets representing unfinished jobs provided all posting is up to date. Therefore regardless of the practice followed concerning the frequency of posting, all material requisitions, time tickets, and vouchers representing direct charges must be posted at end of the cost period.

In addition overhead must be ascertained. If burden is based on direct labor cost, man hours, machine hours, etc., the necessary quantitative data are found and rates applied to get the total overhead. The latter is then posted to the cost sheets, and summarized on a journal voucher, debiting some Work in Process account and crediting Applied Expense. In this way, the live cost cards constitute a book inventory of work in process. As stated by Seeber (NACA Bulletin vol 18).

In taking an inventory of work in process it is only necessary to add the cost of the operations to date and we have the value of our goods in process as close as it would be possible to price any physical inventory.



Along the same line, Rentell and Johnston (Cost Accounting) state

The total accumulated charges on the job order cost cards covering uncompleted jobs at the end of the month can be used as a verification of the departmental Work in Process inventory control accounts

**WORK IN PROCESS CONTROL**—The file of cost sheets may be controlled by

- 1 A single Work in Process account
- 2 Separate accounts for each department or cost center
- 3 Separate accounts for each element of cost

Charges to Work in Process are made from journal voucher summaries. When goods are completed, they are turned over to Finished stock or to the shipping department. Notice to the cost department is given through a finished stock debit memo or similar document. The cost department then goes through the following routine

- 1 Removes the cost sheet from the active file
- 2 Completes the cost sheet by supplying missing postings
- 3 Computes total and unit costs on this order for use by finished stock ledger clerk and subsequent use in costing sales
- 4 Enters cost sheet data on a summary of completed production orders (Fig 10) and files the cost sheet
- 5 At the end of the month prepares a journal voucher on the basis of the completed order summary

SUMMARY OF COMPLETED PRODUCTION						
For Month of _____						
Date	Order No	Material	Labor	Expense	Other Charges	Total

FIG 10 Completed Order Summary by Cost Elements

The summary journal entry is

Finished Goods (or Cost of Sales)	\$	
Work in Process		\$

Where each element of cost is represented by a separate Work in Process control credits are made to

- 1 Material in Process
- 2 Direct Labor in Process
- 3 Manufacturing Expense in Process
- 4 Such items as are indicated in the 'Other Charges' column

Figures for these credits are taken from the **summary of completed orders** which has separate columns for each cost element (Fig. 10).

Where Work in Process controls exist for each cost center credits for completed production are to individual cost center Work in Process accounts. It may however be advisable to make transferring entries in order to keep the accounts in step with the progress of the order in the shop. Such interdepartmental transfers are made according to Restell and Johnston (Cost Accounting) whenever a job is finished in a department. Van Sickle (Cost Accounting) however, suggests less frequent entering. According to this source:

The purpose of separate cost center inventory accounts is to segregate the cost of partially finished jobs by cost centers and thereby provide for greater ease and accuracy in verifying the Work in Process control account balances with the auxiliary job cost records.

Fig. 11, taken from Van Sickle (Cost Accounting) shows how the finished goods transfer is computed. The figures on the completed cost cards are summarized by cost centers, the departmental transfers indicated and accumulated until the finished goods stage is reached.

Finished Jobs	Job Order Number	Cost Center 01	Cost Center 92	Cost Center 03
	1234	\$14 080 00	\$ 9 400 00	\$ 6 240 00
	1235	7 270 00	4 950 00	3 050 00
	1236	4 200 00	4 000 00	2 400 00
		<u>\$25 650 00</u>	<u>\$18 350 00</u>	<u>\$12 700 00</u>
Transferred to Cost Center 02		<u>-25 650 00</u>	<u>+25 650 00</u>	
Transferred to Cost Center 03			<u>\$4 600 00</u>	
			<u>-44 000 00</u>	<u>44 000 00</u>
Transferred to Finished Goods Inventory				<u>\$50 700 00</u>

Fig. 11 Recapitulation of Cost of Finished Jobs by Cost Centers

### FINANCIAL STATEMENTS AND OTHER SUMMARIES —

The financial statements under a job order system are no different from statements prepared under other cost systems. From the accounts there are prepared:

- 1 Profit and Loss Statement supported by
  - a Statement of Cost Production (see Section 5)
  - b Statement of Cost of Sales
  - c Selling Expenses Administrative Expenses
  - d Nonoperating Expense and Income Statements
- 2 Balance Sheet supported by such schedules as are deemed necessary including a Surplus Statement

**Cost Reports in Job Order Plants**—In the case of job order plants significant cost reports cover such items as individual job cost sheets (particularly on orders involving heavy expenditures of time and money), summary cost sheets production center costs, defective work reports costs by lines of product, etc.

**Summary Cost Sheets**—Many job order plants summarize their job costs on special cost sheets. The purpose may be:

- 1 For comparison with past order costs for similar work
- 2 As a basis of cost and price estimates on future work
- 3 For general reference in budgeting, etc.

Hatch describes the procedure as follows (N A C A Bulletin vol 9)

We now total all charges on the job cost card deduct the forgings scrapped from the total pieces forged and divide the total cost by the good pieces to determine the manufacturing cost per piece. This information in summary form together with the selling and administrative cost

CUTLERY							
COST OF							
	Date						
	Stock Blade						
	Stock Handle						
	Stock Total						
	Scrap						
	Net Metal						
	Forging, Rough						
	Handle Finishing						
	Cutlery Finishing						
	Chrome Plating						
	Silver Plating						
	Butler Finishing						
	Scratch Brushing						
	Machine Burnishing						
	Hand Burnishing						
	Buffing						
	Total Labor						
	% Mfg O H						
	Labor						
	% Mfg O H						
	dwt Silver @						
	Net Metal						
	Total						
	% Com'l O H						
	Boxes No @						
	Standard Cost						
	Inefficiency						
	Cost per Gross						
	Cost per Dozen						

FIG 12 Summary Cost Sheet

selling price and profit (or loss) is then transferred to a master cost card which is our comparative record of all orders or lots produced on that particular piece.

Similarly in motion picture production Eisenstein (N A C A Bulletin, vol 15) states:

When a picture is finished a final cost sheet is made out showing the actual cost by classifications as compared to the budget.

Dolliver describes the cost summary for a cutlery manufacturer (N A C A Bulletin, vol 20)

These total cutlery room labor costs are transferred to a summary cost sheet (Fig 12) which includes plating and finishing labor together with the quantity and cost of materials including packing such as boxes and cases. The overheads are also applied on this summary sheet each class of knife having its particular burden rate.

Theit describes a development cost report for an airplane manufacturer (N A C A Bulletin, vol 19)

As most new developments cover a long period of time we believe it is sufficient to make a summarized report at the end of each month (Fig. 13)

The monthly summary of expenditures enables management to follow the cost of development from month to month as compared to the original estimate.

In addition at the end of each week a report is furnished to those responsible for expenditures which informs every one of the progress being made.

#### COST OF DEVELOPING ILLUSTRATED MODEL MONTH ENDING SEPTEMBER 30 19--

Order No	Description	Current Month	Previous Month	Actual Cost to Date	Estimated Total
00100	ENGINEERING AND RESEARCH				
00101	Designing and Drafting	\$18 000	\$17 000	\$ 90 000	
	Research	1 500	800	0 000	
		<u>\$19 500</u>	<u>\$17 800</u>	<u>\$ 90 000</u>	<u>\$100 000</u>
	WIND TUNNEL TESTS				
50100	Labor and Material to construct				
	Airfoil		\$ 9 000	\$ 9 000	
50101	Labor and Material to construct				
	Airplane Model	\$ 1 200	500	1 000	
50111	Engineering Labor	400	300	900	
75100	Purchased Services	8 000	9 000	5 000	
		<u>\$ 4 600</u>	<u>\$ 4 800</u>	<u>\$ 10 100</u>	<u>\$ 10 000</u>
	Mockup				
50900	Labor and Material to construct				
	Mock up	\$ 2 000	\$ 1 500	\$ 5 000	
50901	Purchased Materials (usable)	500		500	
		<u>\$ 2 500</u>	<u>\$ 1 500</u>	<u>\$ 5 500</u>	<u>\$ 15 000</u>
	STRUCTURAL TESTS				
50300	Rivet Test Panels	\$ 100	50	\$ 1 000	
50301	Gas Tank Specimens	400		400	
50302	Test Jig	250		250	
50303	Wing Section Test	1 500	500	4 000	
		<u>\$ 2 250</u>	<u>\$ 550</u>	<u>\$ 5 650</u>	<u>\$ 10 000</u>
	Total	<u>\$24 550</u>	<u>\$24 850</u>	<u>\$116 750</u>	<u>\$265 000</u>

FIG 13 Monthly Summary Development Cost Report

## ACTUAL COST COMPARISON WITH ESTIMATED COST

SERIES A31

QUANTITY OF FIFTY

WEEK ENDING SEPTEMBER 27 19—

No	Description	Current Week			Actual Cost to Date			Estimated Total		
		Matl	Labor	Total	Matl	Labor	Total	Matl	Labor	Total
0	Wing Group	\$	\$	\$	\$	\$	\$	\$	\$	\$
1	Tail Group									
2	Body Group									
3	Landing Gear Group									
4	Power Plant Group									
5	Fixed Equipt Group									
6	Extra Equipt Group									
7	Nacelle Group									
8	Final Assembly									
Totals		\$	\$	\$	\$	\$	\$	\$	\$	\$

Fig 14 Report of Total Actual Cost Compared with Estimated Costs

Figs 14 and 15 used by Ebert (N A C A Bulletin, vol 19) show detailed and summary costs on airplanes. They also serve to illustrate the subdivision of costs of different parts or assemblies.

**COST PER AIRPLANE FABRICATED  
ON ORDER 431—QUANTITY OF 50**

WORK STARTED JUNE 20 19—, COMPLETED DECEMBER 13 19—

	Cost per Airplane Material	Cost per Airplane Labor	Cost per Airplane Overhead	Cost per Airplane Total	Esti- mate Cost
<b>WING GROUP</b>	\$	\$	\$	\$	\$
A31 03 Lower Wings					
05 Ailerons					
07 Flaps					
Total					
<b>TAIL GROUP</b>					
A31 11 Stabilizer					
12 Fin					
13 Elevator					
14 Rudder					
Total					
<b>BODY GROUP</b>					
A31 21 Fuselage					
26 Floor					
28 Baggage Compartment					
Total					
<b>LANDING GEAR GROUP</b>					
A31 31 Main Gear					
32 Shock Struts					
33 Wheels Tires and Tubes					
34 Tail Wheel Gear					
Total					
<b>POWER PLANT GROUP</b>					
A31 41 Engine Accessories					
42 Fuel System					
43 Oil System					
45 Exhaust System					
47 Propellers					
Total					
<b>FIXED EQUIPMENT</b>					
A31 51 Instruments					
53 Air Controls					
54 Stabilizer Controls					
55 Seats					
Total					
<b>EXTRA EQUIPMENT</b>					
A31 61 Radio					
63 Photographic Equip					
67 Oxygen Equip					
Total					
<b>NACELLE GROUP</b>					
A31 71 Engine Mount					
72 Engine Cowling					
73 Nacelle Structure					
Total					
TOTAL FABRICATING COST PER AIRPLANE					

FIG 15 Actual and Estimated Unit Production Cost Analysis

## Assembly Order Costs

**DEFINITION**—Industries which manufacture some parts for stock and purchase others which are subsequently assembled into a finished product issue assembly orders indicating the materials to be assembled. Cost accumulated for these orders are known as **assembly costs**. They are a form of **specific order costs**.

According to Neuner (Cost Accounting), such costs

involve primarily labor and manufacturing expenses since material costs were determined when the parts were manufactured or purchased. The job sheets used for the collection of this cost information are known as assembly or subassembly job order cost sheets.

Assembly costs are used in plants manufacturing electrical parts subsequently assembled in finished form household appliances radios assemblies for automobiles etc.

**ASSEMBLY COST PROCEDURE**—Upon receipt of a sales order an assembly order is issued which authorizes the factory to requisition finished parts from the storeroom and assemble them in accordance with a customer's specifications. The assembly cost sheet shows in addition to the parts required, the labor and overhead expenses incurred in the assembly process. Fig 16 from Neuner (Cost Accounting) is an assembly cost sheet for 150 hand drills. The costs for parts making up these drills are taken from the stores ledger if they are purchased or are based on job order cost sheets if manufactured within the plant.

A more detailed cost procedure is given by Gillespie (Introductory Cost Accounting) as follows:

Thus in an automobile factory wheels, frames and axles (parts) may be manufactured in separate departments and later these parts may be put together to produce the finished assembly i.e. the complete automobile. In such an organization there may be two types of production orders, parts production orders issued to the heads of parts departments and assembly orders issued to the heads of assembly departments. For cost accounting purposes it is necessary to determine the cost of parts and to use the parts cost in determining the cost of the assemblies.

The procedure for assembly costs is illustrated by Gillespie in Fig 17 and explained as follows:

Here it is assumed that parts 'b' and 'c' are manufactured (in Departments 'B' and 'C' respectively) and then stored in a component parts storeroom. These parts are drawn from stores as required and assembled into units of Product "X".

1. A cost sheet is set up for each lot of parts manufactured (i.e. for each parts production order issued) and the cost of production is compiled.
2. When the lot of parts is completed, the parts cost sheet is closed and the cost of the lot of parts is charged to a component parts account (Finished Parts). (These accounts are similar in form and operation to the materials accounts; a separate account is set up for each type of parts stored in a finished parts ledger.)

ASSEMBLY COST SHEET				
Description    Hand Drill		Job Order No 147		
Date Ordered 1/2/—		Date Due 1/20/—	Date Finished 1/20/—	
Quantity Ordered 150		Quantity Finished 150		
LABOR COST				
Date	Operation No. or Description	Hours	Labor Cost	
Jan 11	Assembly #1	7 <sup>2</sup>	\$ 5 25	
13	Assembly #2	41 <sup>6</sup>	3 38	
13	Assembly #3	6 <sup>3</sup>	4 73	
14	Paint	5	3 50	
TOTAL			\$16 86	
MATERIAL COST				
Date	Part No. or Description	Quantity	Price Per M	Total
Jan 11	423	600	\$ 4 53	\$ 2 79
11	463	300	250 25	75 08
11	464	150	450 20	67 53
11	465	150	100 15	15 02
13	484	750	1 50	1 13
13	498	150	35 70	5 36
13	499 Handle	300	160 83	48 25
13	500 Frame	150	4,532 46	679 87
13	501 Wheel	150	751 25	112 69
14	Paint	2	750 00	1 50
TOTAL				\$1,009 15
SUMMARY				
Materials Cost				\$1,009 15
Labor Cost				16 86
Manufacturing Expense Cost, 75% of Labor Cost				12 65
TOTAL				\$1 038 66
Average Cost per M				\$6 924 40

Note The arrangement on this form is suitable for use with accounting machines of the adding machine type

FIG 16 Assembly Cost Sheet



## FLOW OF COST DETAILS - PARTS MANUFACTURED AND STORED FOR LATER ASSEMBLY

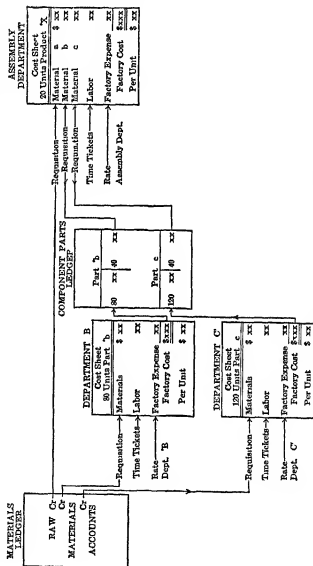


FIG 17 Flow of Cost Details for Assembling Costs

[illegible]

Fig. 18—Individual parts produced cost record used in conjunction with job order cost accounting system. Fig. 19—Purchase record of raw materials for individual parts or manufactured parts for subassembly. Fig. 20—Subassembly cost record to record assembly labor charges and parts produced or purchased with respect to job order cost accounting system. Fig. 21—Final assembly cost record used in conjunction with job order cost system.

- 3 Parts are drawn from stores by means of parts requisitions. Parts requisitions are
  - a Credited to parts accounts
  - b Charged to assembly cost sheets
- 4 An assembly cost sheet is set up for each assembly production order. The cost of assembling the lot is compiled on this cost sheet.
- 5 (Not illustrated in the diagram) When an assembly order is finished the assembly cost sheet is completed, removed from the assembly ledger and charged to a Finished Assemblies account.

Figs 18-21 covering forms used in connection with the manufacture of carburetors illustrate the problem of determining the costs of individual parts to be used later in final assemblies, purchasing manufactured parts from outside vendors, recording subassembly, and final assembly costs.

A record of manufactured parts and other raw materials is kept, separate from the usual stores records. The individual parts produced are recorded on Fig 18. Castings and other parts used in the finished product, if purchased from outside vendors and which are to be used in assemblies are recorded on Fig 19. These two records form the basis for material consumption entries on the subassembly cost record (Fig 20). Provision is also made on the latter form to record direct labor charges. As parts completed under subassemblies are used for final assembly they are entered on a final assembly record (Fig 21). Information on this form is taken from the various subassembly cost records as to material and labor charges. Overhead applied is shown in the summary at the top of the form. The manufacturing costs are expressed as costs per 100 pieces divided between material, labor and overhead. The form has the advantage of comparing the costs per 100 from different runs.

**RELATION OF SALES ORDERS TO PARTS ORDERS**—In many instances where sales orders are received from customers for complete units composed of finished parts and assemblies a production order is broken up into a series of parts orders. These are manufactured in separate departments and stored in special finished parts stores rooms. Thus, in discussing this type of costs, Moonman (NACA Bulletin vol 13) states:

A Production Order Record is made up for each part produced in the plant. The necessary information regarding material and weight of the material required for one piece is shown and serves the purpose of making up the production order for the plant. As each production order is sent to the factory the fact is so indicated in the spaces provided. When the work covered by the production order is completed the information of quantity received by the stockkeeper is filled in.

Ebert, discussing airplane manufacturing costs (NACA Bulletin, vol 19), speaks of the release of orders for production as follows:

When an airplane order either experimental or production is ready for fabrication the engineering department prepares a list of all blue prints covering the parts necessary to construct the airplane. When the order is released to the shop for fabrication the engineering department forwards this list to the production department. The production department then proceeds as follows:

- 1 Assigns order number and prepares schedule
- 2 Prepares work order
- 3 Prepares route tag
- 4 Prepares requisitions

The production department being informed as to the delivery schedule prepares a master production schedule indicating when each major unit is needed. After the master production schedule is completed a schedule of the detailed parts in each department is prepared so that a complete picture of what must be done to accomplish the production schedule is available.

**CODING FOR PARTS**—In order to avoid confusion clear identification must be provided for all parts used in assemblies. Such identification must start on the parts cost sheet and then follow through to the assembly cost sheet. The following classification covering airplane parts is taken from Ebert (N A C A Bulletin vol 19)

An airplane consists of many small parts assembled into a relatively small number of major units that can be handled and sold separately. Consequently most airplane manufacturers accumulate costs on their production by major assemblies separated by function such as structural parts, fixed equipment and extra equipment. This is accomplished by establishing unit designating numbers as shown in Fig 13. Each group is broken down as follows:

- |   |   |
|---|---|
| <b>0 WING GROUP</b><br>01 Upper Wings<br>02 Center Wings<br>03 Lower Wings<br>04 Ailerons | <b>4 POWER PLANT GROUP</b><br>41 Engine and Accessories<br>42 Fuel System<br>43 Oil System                      |
| <b>1 TAIL GROUP</b><br>11 Stabilizer<br>12 Fin<br>13 Elevator<br>14 Rudder                | <b>5 FIXED EQUIPMENT</b><br>51 Instruments and Boards<br>52 Seats<br>53 Air Controls<br>54 Electrical Equipment |
| <b>2 BODY GROUP</b><br>21 Fuselage<br>22 Baggage Compartment                              | <b>6 EXTRA EQUIPMENT</b><br>61 Radio<br>62 Oxygen Equipment<br>63 Photographic Equipment<br>64 Flame Equipment  |
| <b>3 LANDING GEAR</b><br>31 Main Landing Gear<br>32 Tail Wheel Gear                       |   |

The list of numbers shown is not complete but is enough to show the unit grouping and can be broken down into three numbers to get detailed costs for example:

- 42 FUEL SYSTEM ASSEMBLY**  
 421 Main Gas Tank  
 422 Lines and Connections

The coding and classifications in Fig 14 are slightly different from those in Fig 13.



## SECTION 9

### CONTINUOUS PROCESS COST SYSTEMS

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## SECTION 9

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### CONTINUOUS PROCESS COST SYSTEMS

#### Definitions and Characteristics

**DEFINITION OF PROCESS COSTS**—Process costing represents a type of cost procedure for continuous or mass production industries. In such industries output consists of like units, each unit being processed in like manner. Therefore it is assumed that the same amount of material, labor, and overhead is chargeable to each unit processed. The cost of a unit at the end of any manufacturing process can be readily determined provided costs are accumulated on a process basis and a record of units produced is available. As stated by Newlove and Garner (Elementary Cost Accounting).

When reduced to its barest essentials process cost accounting is the procedure by which unit product costs are obtained (on a historical basis) through the application of some type of averaging technique.

It is however, not necessary that process costs be on a historical basis. Such costs may be obtained on a basis of standard as well as actual costs.

Amidon and Lang (Essentials of Cost Accounting) emphasize the conditions favoring process costs:

Any industry manufacturing a product in mass or bulk making differentiation of articles difficult or impossible will find use for process costs.

Thus the conditions for use of process costs are:

- 1 Continuous or mass production
- 2 Loss of identity of individual items or lots
- 3 Complete standardization of product and processes

**CHARACTERISTICS OF PROCESS COSTS**—The characteristics of a process cost system are:

- 1 Accumulation of material, labor, and manufacturing expenses by processes
- 2 Accumulation of costs on a time basis usually daily, weekly, or monthly
- 3 Use of production reports to indicate operation process or departmental output
- 4 Averaging costs of each process over the output to secure the cost per unit per process
- 5 Costs must follow the product hence costs are accumulated and transferred from process to process as the product is transferred



**PROCESS TYPE OF PRODUCTION**—Many companies, though manufacturing for stock, accept orders from customers in advance of manufacture. Other companies, catering largely to custom trade, occasionally manufacture for stock. Consequently, many manufacturers vary their specifications from time to time and find it necessary to accumulate costs by job orders. At best there is a tendency for the job order to predominate in some concerns while in others the process method tends to prevail. As stated by Dohr, Inghram, and Love (Cost Accounting)

It is not necessary that the entire plant be placed on the same basis in so far as the cost methods are concerned and if necessary the cost system will include the job order basis for one department the process basis for another and so on. In every case the best method should be selected having in mind the nature of the product the result desired and the cost of obtaining such results.

According to Van Sickle (Cost Accounting) process costs are used extensively in

- 1 Some manufacturing industries
- 2 Mining operations
- 3 Public utilities

Specific illustrations of the manufacturing group are those industries engaging in the continuous process production of commodities for finished goods stock such as foundries blast furnaces tin and iron mills cement and lime mills, pipe and pipefitting manufacturers paper and rubber manufacturers automobile plants paint factories ceramic plants food product concerns and ice manufacturers.

Examples of the mining and quarry groups are coal sulphur clay stone and sand companies.

Public utilities engaged in the production of electric power steam heat and artificial gas and the pumping of water use process cost systems.

In general, plants using process costs may be classified as follows

- 1 Production of a single product
- 2 Production of a variety of products using the same productive facilities
- 3 Production of a variety of products using separate facilities, that is a separate plant for each product

Examples in the first group are found in the manufacture of ice, cement sugar, bricks chemicals etc. Next are those plants that manufacture a variety of products using the same productive facilities. Production may be carried on simultaneously on several products or by successive runs. Illustrations are the manufacture of different styles, types and sizes of toys, different types of brick, tile ceramic products etc. Finally there are those plants that produce a variety of products from specialized equipment. This may be done by subdividing a plant each subdivision specializing in one product, or building separate plants for each product. Thus the last named group is much like the first since each plant manufactures but one product. For example du Pont has separate plants for the manufacture of gunpowder, synthetic camphor, rayon nylon, etc.

**ADVANTAGES AND DISADVANTAGES OF PROCESS COSTS**—The chief advantages of process costing are

- 1 Costs are computed periodically usually at the end of the month only
- 2 Base in computing average costs provided the product is homogeneous
- 3 Less clerical effort and expense than in job order costing

As opposed to these the disadvantages of process costing are

1 Where historical process costs are used, they are not determined until the end of the cost period. This has a tendency to delay statement preparation

2 Average costs are not always accurate. This point is emphasized by Lawrence (Cost Accounting), who gives the following illustration based on foundry costs

Foundry costs were formerly computed by the process method and applied to the product on a per pound basis regardless of size or kind of castings. In fact however the product of a foundry consists of both large and small castings some of either size being much more difficult to make than others so that the average cost found by the process method does not apply correctly to many castings

3 Where different products are manufactured the pinpointing of cost elements is necessary and the computation of average costs made more difficult

4 Inaccuracies in unit costs are reflected in inventory values of work in process finished goods and cost of sales especially where in computing unit costs it is often necessary to take into account the stage of completion of the closing inventories. This must usually be estimated and thus further weakens the accuracy of unit cost figures. The point is stressed by Reitel and Johnston (Cost Accounting)

The averaging method which is used to compute the cost of the partly finished products in different departments as well as the value of the Work in Process inventory at the end of the month is one of the inherent weaknesses of the process cost system. If the method of averaging is faulty the effect is far reaching. The cost of the units partly finished in one department is estimated. If the estimate is inaccurate the cost transferred to the next department is inaccurate. Such an inaccuracy is carried through all of the Work in Process Inventory accounts to the Finished Goods and Cost of Sales accounts. The inaccuracy ultimately is reflected in the net profit. Faulty averaging methods are reflected also in the Work in Process Inventory account balances which represent the value of the partly finished units at various stages of completion. These balances if erroneously valued likewise carry a misstated cost value into the following month's costs

5 Where process costs are used on an actual cost basis only the system shares all the disadvantages of any actual cost scheme. By the very nature of process cost accounting as an averaging method management may overlook inefficiencies in operations unless great care is exercised in isolating these inefficiency factors through the use of standards supplementary to process costs. This point is emphasized by Blocker (Cost Accounting)

Management is led to believe that actual costs are the result of efficient operation when in reality actual costs may include excessive quantities of material defective parts ineffective use of labor and an unnecessary time in production. In other words the cost analysis may not be an indicator of efficient plant operation. In addition to actual costs management needs

a means of appraising or measuring the efficiency with which materials labor and overhead expenses are combined in the finished product

### COMPARISON OF JOB ORDER AND PROCESS SYSTEMS

—These two systems differ as to methods of production and methods of cost determination. Fig 1 shows a comparison of both systems on

PRODUCTION	Job Order	Process
	<ol style="list-style-type: none"> <li>1 By specific orders</li> <li>2 On customer's specifications</li> </ol>	<ol style="list-style-type: none"> <li>1 Continuous flow</li> <li>2 Homogeneous product</li> <li>3 For stock</li> </ol>
Costs	Job Order	Process
	<ol style="list-style-type: none"> <li>1 Determined by job orders</li> <li>2 Prime costs and burden segregated in accounts</li> <li>3 Calculated when job finished</li> </ol>	<ol style="list-style-type: none"> <li>1 Determined by units of product</li> <li>2 For each department or process</li> <li>3 Calculated at end of cost period</li> <li>4 Transfer of costs from process to process</li> </ol>

FIG 1 Job Order and Process Methods Compared

the basis of these factors. Aside from these factors, the actual organization and operation of the process cost records have many things in common with other cost systems. Harold (NACA Bulletin 10121) explains the features of process costing connected with plate glass manufacture that are common to any cost accounting system. They are

- 1 Accounting system is controlled by means of a group of accounts recorded in a factory ledger
- 2 All departments fall into one of two classes
  - a Production
  - b Service or auxiliary
- 3 All charges for material and labor to all accounts and departments are controlled by a catalog of charges which classifies them into divisions of cost
- 4 A predetermined rate is used whenever practicable to absorb the overhead of a nonproductive or service department
- 5 The usual records pertaining to stores disbursements stores distribution payrolls and payroll distribution are provided for together with such records as are necessary to provide at the end of each month the weights or quantities of all raw materials and operating supplies used
- 6 Production records in connection with the operating departments are maintained to furnish production data and amounts of losses and breakage

### Departmentalization

**PROCESS DEFINED**—In process costing, the terms process and department are used interchangeably. A manufacturing process according to Dohr, Ingham and Love (Cost Accounting) is

a part or phase of the complete set of activities through which the product passes in the course of manufacture. A completed product results from a series of processes in each of which some change is made in the material.

Blocker (Cost Accounting) describes a department as one that includes a number of operations none of which is separately measurable and each of which completes a distinct stage in the manufacture of a product. The boundaries of the process are determined by

- 1 Jurisdiction or supervision
- 2 Similarity of work performed
- 3 Physical location of men and machines in the plant

Hence, in order that costs may be accumulated on a process basis it is necessary to departmentalize the plant and to indicate the limitations of each department or cost center. Thus a shirt manufacturer departmentalizes his plant so as to be able to accumulate the costs of cutting, sewing, finishing, and packing. All material, labor, or overhead applicable to a process or department is charged to the process or department as a means for ascertaining departmental unit costs of processing.

Proper departmentalization makes possible the accumulation of process cost data on a uniform basis. The size of a department is a matter of convenience and operating efficiency. According to Blocker (Cost Accounting)

The factory may be divided into processes which include relatively large spheres of activity or into operations or cost centers limited to a single operation.

This is further emphasized by Newlove and Gainer (Cost Accounting)

The unit adopted for cost purposes may be unwieldy if too many operations are joined to make a department. Even though more departments make for more accurate cost accounting it is quite easy to overdo the matter and create an organization which is so decentralized and divided that management cannot supervise the operations in the most effective manner.

**SELECTION OF PROCESSES**—Bennett in discussing cost accounting for a cotton mill (N. A. C. A. Bulletin, vol. 21) states that for purposes of burden application four centers were found sufficient. He points out, however, that management wanted the mill cost data broken down into natural departmental divisions if it did not involve unnecessary clerical detail, and if they would provide a continuous guide to operating results, costs and efficiency levels for the assistance of all divisions of the management from the chief executive down the line to the departmental overseer. Accordingly, the following eleven centers of burden application and cost analysis were determined upon:

- |                                |                            |
|--------------------------------|----------------------------|
| 1 Picking                      | 6 Slashing and drawing in  |
| 2 Carding and combing          | 7 Silk winding and warping |
| 3 Spinning                     | 8 Weaving                  |
| 4 Spooling warping and winding | 9 Cloth room               |
| 5 Doubling and twisting        | 10 Dyeing and finishing    |
|                                | 11 Packing room            |

In the manufacture of mechanical rubber products there are five stages. These are explained by Halligan (N. A. C. A. Bulletin vol. 19)

- 1 Preparatory Operations These include
  - a Opening bales or cases
  - b Cutting rubber into segments or sheets
  - c Washing drying etc to eliminate foreign matter
- 2 Processing In the processing division rubber pigments are measured mixed and then combined with cotton fabrics or other materials comprising the component parts of a finished rubber article. The operations involved are
  - a Compounding
  - b Milling
  - c Calendering
- 3 Cutting and shaping of component parts
- 4 Curing and vulcanizing
- 5 Finishing and packing. Operations include testing, inspecting finishing, and packing of product

Departmentalization in a sole leather tannery is described by Stevenson and Slack (N A C A Bulletin vol 14)

There are 11 departments for direct process costing two departments for by product costing, and six departments the costs of which are allocated to the above 13 departments namely

**Direct Departments—**

Soaks	Bleaching
Limes	Oiling
Unhairing and Fleshing	Rough Loft
Rockers	Rolling
Limits (1-5)	Finishing
Extracting	

**By Product Departments—**

Hair	Fleshing
------	----------

**Indirect Departments—**

General	Bain
Power	Leach House
Switching	Hide House

Note the presence of **service departments** which are the same as in any other system. They are redistributed to the others before process costs for a period can be computed.

The cement industry furnishes an example of coordination between physical processes and accounting methods. These are discussed by Smith (N A C A Bulletin, vol 23). There are four cost centers

- 1 Raw Material No 1—Rock (Limestone)
- 2 Raw Material No 2—Shale
- 3 Clinker
- 4 Cement

Each of these is subdivided to show operations involved. For each raw material the operations are

- a Stripping (removal of top soil)
- b Production (excavating and transporting to mill)
- c Crushing and coal storage

The clinker process includes

- a Raw grinding
- b Blending and storage tanks
- c Burning
- d Cooling and storing

The cement process covers clinker grinding and storage. The cement is not packed in containers until shipment is to be made. Packing and Loading expense is added to the bin cost of cement at that time.

## Process Cost Procedure

**PROCESS PRODUCTION ORDERS**—Where production is continuous, special production orders are not required. This is the case in ice plants, mining, quarrying, steam plants, etc. This involves planning of the work so that continuity of production is maintained. Starting with the sales budget and making allowance for seasonal variations, returns, inventories, etc., production quotas are set by months or other convenient time interval. Notice of these quotas is given to the production control section, which in turn transmits them to the producing centers.

Where several products are manufactured, orders must be planned and issued much as in job order plants. An excellent illustration is a bakery, because it produces a variety of perishable products in which demand and production must be synchronized daily to avoid excessive stale loss. Hence daily **bake orders** are resorted to. They are described by Henry (N. A. C. A. Bulletin, vol. 20) as follows:

Salesmen make up their orders two days in advance of delivery. These orders are pre-board forms which are cross added and balanced by computer operators; the totals being posted to a **combined total order**. The combined total order shows the quantities of trade brands ordered and must be transferred to a **daily bake shop order** which shows the quantities of various types of doughs required. Using the bake shop order as a basis, the bake shop superintendent calculates the number and kinds of doughs to be mixed and the number of men hours required. A shop schedule is then compiled which routes each dough through the various processes and machines in the proper sequence. Formula cards are prepared for each dough required, showing the weights of the ingredients to be mixed together with schedules of mixing and fermentation times, and temperatures at various stages.

In leather tanning, process costs are collected daily and apportioned to **tanning orders**. These are explained by Stevenson and Slack (N. A. C. A. Bulletin, vol. 14):

A tanning order is made out (in duplicate) on which is shown the sequence number, the date of working, the number of hides and sides, the stamp (lot) number, the green salt weight and the white weight. One copy (yellow) is retained in the office while the other copy (white) is sent out into the tannery. The office copy is used for the accumulation of costs while the white copy follows the sides from one department to another until it has gone through the entire process and at that time the original finished weight of leather is endorsed on the bottom of the order and then returned to the office. As this tanning order proceeds from one department to another, the date of passing the departments is marked on the order.

**FUNCTIONS OF PROCESS COSTING**—The purpose of process costing is to accomplish the following ends:

- 1 To accumulate and distribute service department expenses.
- 2 To compute unit conversion cost for each process at the end of each cost period.

- 3 To transfer costs from process to process To do this it is necessary
  - a To price transferred product on the basis of an average unit cost
  - b To place a value on inventory of work still remaining in process

Harold (N A C A Bulletin vol 21) describes the functions of process costing as follows

This method the process method must provide an average cost of production by periods In the process method of manufacture the product usually passes through producing departments in a certain sequence Each department performs a particular step and when the product has passed through the last operation it is in salable form Cost finding accordingly involves tracing the product from the raw materials through the various producing departments and finally to the finished state Each stage or producing department adds to its own costs those of the preceding stages The costs by departments are accumulated in a factory ledger

**STEPS IN PROCESS COSTING**—Blocker (Cost Accounting) lists the following steps in process cost accounting

- 1 Costs both direct and indirect, are accumulated in expense accounts during the period and are reclassified by departments or processes at the end of the period
- 2 Production in terms of quantities such as units tons pounds feet and gallons are recorded by processes daily or weekly and are summarized in departmental reports at the end of the period
- 3 The total cost of each process is divided by the total production for the process to obtain an average cost per unit for the period
- 4 When products remain in process at the end of a period production and inventories are computed in terms of completed products the stage of completion usually being estimated and the identity of each lot being ignored
- 5 If units are lost or spoiled in a department the loss is borne by the units completed and remaining within the department thus increasing the average cost per unit
- 6 In cases where products are processed in more than one department costs of one department are transferred to the next department the total cost and unit cost of products being accumulated when completed

To carry these out it is necessary to combine accounting data with figures for physical quantities during the cost period and at the end of the period The following outline is taken from Gillespie (Introductory Cost Accounting)

#### Current Records

- 1 Compile cost and weight (or other measure) of materials purchased
- 2 Compile
  - a Weight of material used
  - b Weight of partly finished materials transferred from one department to the next in succession
  - c Weight of product completed and transferred to finished product stores
  - d Weight of product sold
- 3 Compile cost of labor supplies and factory expenses by departments

#### Monthly Closing

- 1 Total the service costs for the month and distribute to using departments
- 2 Total the producing department costs, and determine the unit conversion cost for each department

## j Prepare transfer entries for

- a Raw materials used
- b Partly finished goods transferred to next department
- c Product completed

**OPERATION OF PROCESS ACCOUNTS**—Costs for material, labor and manufacturing expense are charged to the usual accounts analyzed by processes, and distributed by appropriate journal entries to process accounts. Production figures are reported daily by processes and accumulated for the entire cost period. For purposes of computation by the cost accounting department at the end of the month a record of production must show the following information relative to quantities

- 1 Finished product on hand at beginning of period
- 2 Goods still in process at beginning of period and then stage of completion expressed in percentage form
- 3 Quantity received from preceding process
- 4 Quantity delivered to next succeeding process
- 5 Finished product on hand in process at end of period
- 6 Goods still in process at end of period and stage of completion

On the basis of production figures and figures in the process accounts the cost department computes average unit costs and prepares journal vouchers to cost

- 1 Production transferred to next process
- 2 Inventory on hand in each process

**RECORDING PROCESS COSTS**—Costs may be recorded in process accounts by any one of the following methods

- 1 Use of a single work in process control account
- 2 Use of a separate work in process account for each process i.e., departmental work in process accounts
- 3 Use of a work in process account for each element of cost. Material, Labor, Overhead
- 4 Use of a work in process account for each product with further subdivision for each product in each department or by elements for each product, etc

**Single Work in Process Account**—The degree of subdivision of the cost accounts varies with the complexity of the manufacturing operations. A single Work in Process account is advantageously used in plants producing a single product. Examples are ice plants, blast furnaces, tanneries, steam plants, etc. Many such plants operate continuously and do not have any closing inventories. It is merely necessary to assemble figures for material, labor, and overhead in a Work in Process account and divide the total by the figures shown in the production report to arrive at the average unit cost. Thus, Stevenson and Slack report (N.A.C.A. Bulletin vol 14) that a certain leather company charges all costs to a Goods in Process account in the general ledger. In this case the account is supported by tanning orders. When a tanning order is completed, Finished Goods is charged and Goods in Process credited.

Where many processes are involved it is advisable to use a single Work in Process account as a control account, and support it by individual process accounts in a subsidiary process ledger. This is analogous to a



job order system where Work in Process is supported by a file of active cost sheets. In process costing, the control account is supported by a process ledger containing accounts for individual processes.

**Multiple Work in Process Accounts**—Too great refinement in subdividing Work in Process complicates the cost procedure and increases clerical expense. If process costs are wanted in great detail and in many subdivisions, the best procedure is to put the information on **punched cards**. These can then be sorted in any desired classification on regular sorting and tabulating equipment. Use of such equipment makes possible the preparation of production cost analyses by

- 1 Total costs
- 2 Elements of cost
- 3 Departments or processes
- 4 Products

Vin Sicle (Cost Accounting) illustrates this type of multiple classification (Fig. 2). He also shows an example of cost accumulation in departmental process accounts as follows:

17-51	Work in Process Inventory—Dept 51	\$35 250 00	
17-52	Work in Process Inventory—Dept 52	18 000 00	
17-53	Work in Process Inventory—Dept 53	10,000 00	
51-71	Direct Materials Used—Dept 51		\$15 000 00
52-71	Direct Materials Used—Dept 52		6 000 00
53-71	Direct Materials Used—Dept 53		9 000 00
51-72	Direct Labor—Dept 51		9 000 00
52-72	Direct Labor—Dept 52		4 000 00
53-72	Direct Labor—Dept 53		5 000 00
51-73	Overhead Expense—Dept 51		11 250 00
52-73	Overhead Expense—Dept 52		6 000 00
53-73	Overhead Expense—Dept 53		5 000 00
To close the cost elements for the month into Work in Process inventory accounts			

The same information gathered into work in process accounts, subdivided by cost elements, reads as follows:

17-71	Direct Materials in Process	\$30 000 00	
17-72	Direct Labor in Process	18 000 00	
17-73	Overhead Expense in Process	22 250 00	
51-71	Direct Materials Used—Dept 51		\$15 000 00
52-71	Direct Materials Used—Dept 52		6 000 00
53-71	Direct Materials Used—Dept 53		9 000 00
51-72	Direct Labor—Dept 51		9 000 00
52-72	Direct Labor—Dept 52		4 000 00
53-72	Direct Labor—Dept 53		5 000 00
51-73	Overhead Expense—Dept 51		11 250 00
52-73	Overhead Expense—Dept 52		6 000 00
53-73	Overhead Expense—Dept 53		5 000 00
To close the cost elements for the month into Work in Process inventory accounts			

Where a plant makes different products, each product using separate plant facilities, a separate cost system for each division of the plant must be installed. This point is emphasized by Reitel and Johnston (Cost Accounting).

	Total	Cost Elements			Production Department			Production		
		Direct Materials in Process	Direct Labor in Process	Overhead Expense in Process	\$1	\$2	\$3	P	Q	R
Charges originating during January										
Direct Materials	\$30 000 00	\$30 000 00			\$15 000 00	\$6 000 00	\$9 000 00	\$1 000 00	\$10 000 00	\$8 000 00
Direct Labor	18 000 00	18 000 00	\$18 000 00		9 000 00	4 000 00	5 000 00	8 000 00	6 000 00	4 000 00
Overhead Expenses	22 250 00			\$22 250 00	11 250 00	6 000 00	5 000 00	10 100 00	7 4 0 00	4 7 5 00
Charges units production during January										
Defective work created during January	\$70 150 00	\$70 000 00	\$18 000 00	\$22 30 00	\$35 250 00	\$16 000 00	\$19 000 00	\$30 100 00	\$3 410 00	\$16 725 00
Net production charges during January	150 00	60 00	30 00	45 00	60 00	50 00	40 00	150 00		
Work in Process Inventory, January 1	\$70 100 00	\$9 031 00	\$17 964 00	\$22 205 00	\$35 100 00	\$15 050 00	\$18 960 00	\$70 9 8 00	\$3 415 00	\$16 7 6 00
Total net production charges during January, 19__	6 000 00	0 0 00	1 500 00	1 830 00	2 500 00	1 000 00	1 600 00	2 000 00	000 00	1 000 00
Work in Process Inventory, January 31, 19__	\$76 100 00	\$32 604 00	\$9 464 00	\$22 035 00	\$35 690 00	\$17 850 00	\$20 560 00	\$33 038 00	\$5 415 00	\$1 6 00
Cost of Production	8 100 00	3 56 00	2 114 00	2 30 00	3 690 00	2 850 00	1 560 00	3 928 00	415 00	1 7 0 00
Units produced	260 000 00	\$9 345 00	\$17 350 00	\$21 305 00	\$34 000 00	\$15 000 00	\$19 000 00	\$32 000 00	\$3 000 00	\$16 000 00
Unit cost for January								\$0 00	\$5 00	\$10 00

Fig 2 Multiple Production Cost Analysis

In a plant producing a widely varying line of commodities the nature of the operations for each commodity produced often varies widely. It would be impracticable to have such a plant laid out on a purely departmental plan. The processes required and the departments in which the manufacture of an electric fan takes place have no connection with the different processes required in the construction of an electric transformer. The solution therefore lies in arranging the plant in divisions in which the production of widely different commodities is segregated. Within each division there may be departments or cost centers where like classes of work are performed. Divisionalization permits of gathering more accurate costs. In reality each division is a small factory in itself.

In such cases costs may be centralized by using a separate factory ledger for each division, each such ledger being represented by a suitable account on the general ledger of the main or central office.

Where a variety of products is turned out in the same departments material and direct labor costs must be kept track of through requisitions and time tickets. Factory overhead is best charged to the product through use of predetermined expense rates.

**PRODUCTION RECORDS**—Records of quantities are intended to measure the flow of product through the plant from the time of the receipt of raw material to the time of final shipment. Daily production reports are compiled. These keep management informed of actual achievements with respect to scheduled production quotas, and furnish one of the necessary elements in cost computations by the cost department.

Production figures may often be obtained from meters attached to machines, readings being taken at the beginning and end of each day or run. In some plants finished units are counted by timekeepers or inspectors, either by physical count or automatic scales. Daily reports of production for each process are summarized to constitute a monthly or end-of-the-period production report.

**MATERIAL COSTS**—In general, accounting for material under a process cost system is the same as for any other type. This involves the use of perpetual inventory controls. Emphasis is however on providing means for charging materials to the proper process and product at the time of consumption. According to Adamson (N. A. C. A. Bulletin vol 15) a sulphur manufacturing company uses tabulating equipment to enable it to sort the punched cards for materials requisitioned by departments, class and kind.

Often only a small number of raw materials are used. This is particularly the case in plants making a single commodity. In such cases accounts may be kept with each raw material in the general or factory ledger. In ice making, for example, materials consist of ammonia, calcium, and water. In the making of pig iron the ingredients are iron ore, coke, limestone, and scrap iron. For this type of manufacturing even material requisitions may be dispensed with, and so-called consumption reports substituted. These reports may be prepared in two ways:

1. By formula or by proration
2. By special summaries or by physical count

**Consumption Reports by Formula**—In continuous process plants it is often impracticable to use material requisitions since raw materials

[illegible][illegible]

### Fig 3 Consumption Formula Sheets

flow into the process in a steady stream. It is sometimes possible, however, to tell how much material was consumed in production from a knowledge of the quantity of finished product produced. In plants manufacturing chemicals the raw material content is readily determined from production reports on the basis of what is known in chemistry as the **Law of Definite Proportions**. According to this principle different elements combine with each other in certain definite ratios.

Consumption reports by formula (Fig. 3) are particularly useful in connection with **standard costs** since the formulas then become standards. Use of formulas for the baking industry is explained by Ulrich (N.A.C.A. Bulletin vol. 16).

Materials are accounted for by ingredients and charges are made for weight and cost. Weights are charged as "formula," and "purchase." An analysis ledger is maintained in which accounts are set up for each group of ingredients. The form of the account provides space for recording and summarizing formula weights, purchase weights, and cost.

Formula weights are charged from a summary of the "Formula Sheets" (Fig. 3). These formula sheets are prepared from the bake shop orders and show the various doughs to be made and weights of the ingredients to be used. The columns provided on the sheet are totalled daily for use in the preparation of a daily manager's report and are summarized monthly for posting to the analysis ledger. Purchase weights and costs are posted to the analysis ledger from the material stock ledger.

Harold (N.A.C.A. Bulletin, vol. 21) explains the formula method in plate glass manufacture.

The quantity of each raw material such as sand, soda ash, salt, coke, lime, stone, etc., used in preparing the mixed batch charged to the tank department is developed by means of a very carefully prepared formula. By multiplying the quantity of each material in a batch of a certain mix by the number of batches of that particular mix made during the month, including an allowance for loss, the quantity of each raw material consumed is determined.

**Prorated Material Costs**—Sometimes material costs are prorated to the product on the basis of some physical coefficient such as tonnage, etc. In Fig. 4 the cost per pound is determined by dividing the raw material cost of \$20,000 by the total poundage, and using the resulting unit cost as a basis for charging the material cost to each product. The same result can be obtained by expressing the poundage of each product as a percentage of the total weight and applying these percentages to the total cost to obtain the apportioned costs for each product. An illustration of its use is found in the manufacture of dolls. Different sizes and styles of composition dolls' heads are made from the same compound and costs are prorated on a weight basis. The method of proration is

	Total	Product A	Product B	Product C
No. of units produced	10,000	4,000	5,000	1,000
Average weight per unit	1.6 lbs.	1.25 lbs.	1.4 lbs.	4 lbs.
Total pounds produced	16,000 lbs.	5,000 lbs.	7,000 lbs.	4,000 lbs.
Material cost per pound	\$1.25	\$1.25	\$1.25	\$1.25
Raw material proration	\$20,000	\$6,250	\$8,750	\$5,000
Material cost per unit	\$2.00	\$1.5625	\$1.75	\$5.00

FIG. 4. Proration of Raw Material Costs

usually not satisfactory since it tends to produce inaccuracies in unit product costs. The inaccuracy of such costing is due to variations in waste and spoilage on different runs.

**Consumption Reports by Special Summaries or Physical Count.**—Material control for cotton mills is obtained through summary consumption reports, as explained by Bennett (NAC A Bulletin vol 21).

**Cotton.**—Summary consumption reports taken from perpetual inventory records by classes of cotton are prepared and priced at cost. Complete physical count at any one time is unnecessary; sectional physical counts made continuously provide the needed check on book inventories.

The same procedure is followed for rayon yarn. However, usage of other material and supply items though kept on a perpetual inventory basis, is determined on the basis of physical inventories. Bennett states:

**Cotton Yarn.**—Monthly inventories of cotton yarn are readily taken and determine the cost of yarn used.

**Dyestuffs.**—Dyestuffs were kept in two places in this mill: (1) a store room where full bags and barrels were kept and (2) the drug room where opened containers were kept and where the drings were weighed out before being delivered to the dyehouse. Perpetual inventories were kept of the goods in the storeroom and test checks of quantities were made periodically. Dyestuffs in the drug room were inventoried each month.

Because of the multiplicity of items which comprise the usual list of dyestuffs and drugs used in a finishing plant I always recommend monthly physical inventories of materials in the drug room instead of depending upon reports of quantities used. My experience with the latter has been uniformly bad.

**Waste.**—All purchases of waste were charged to this account; also all manufactured waste on hand at the close of the fiscal year that was included in inventories. While it would have been relatively simple to obtain reports of waste used as a basis of the monthly transfers to work in process, it was found that monthly physical inventories involved even less detail and assured fewer chances of error; therefore monthly physical inventories were taken.

**Material Controlling Accounts.**—Where the number of raw material items handled is large, it is best to open a Stores control account supported by a subsidiary balance of stores ledger. This condition occurs when several products are produced concurrently. Raw materials are requisitioned in the usual manner by formal requisitions, bills of material, etc. The requisitions must indicate the department in which the material is used and the product for which it is requisitioned.

Only in this way is it possible to analyze material costs properly at the end of a cost period. If the product is not indicated, departmental material cost must be prorated as in Fig. 4.

O'Connell advocates the use of two controlling accounts in connection with accounting for material in liquor distilleries (NAC A Bulletin vol 15):

1. **Stores.**—Process Ingredients. This account is charged with cost of process ingredients such as hops, caustic soda, sulphuric acid and juniper berries (used in gin) acquired by purchase. The account should be credited with the cost of all ingredients used, the charge being to the proper manufacturing account. There should be a perpetual inventory record maintained for each of these process ingredients.

- 2 Stores—Denaturants This account should be charged with the cost of all denaturants purchased or otherwise acquired. The account should be credited with the cost of denaturants used in manufacture or otherwise disposed of. A perpetual record should be kept.

**DIRECT LABOR PROCESS COST**—Some accountants have advocated abolition of the distinction between direct and indirect labor since both types are charged to the same process account. This is short sighted. Even though the over-all process costs are unchanged the component elements are misstated making effective cost control difficult if not impossible. This point is emphasized by Bennett in discussing cotton mill costs (N A C A Bulletin vol 21)

Under the usually accepted mill methods, the entire payroll of a productive department is treated as a single cost element of "labor" without any attempt to break it down into its two fundamental elements of direct and indirect labor. By combining the direct and indirect labor cost of any given product in any given operation a result is obtained which means only that the cost is so much.

His suggested remedy is to analyze carefully all labor on the basis of a strict labor classification and maintain this separate identity through all stages of the accounting control and proof mechanism.

**Labor Classifications**—The essential requirement is to analyze labor by processes. This would involve classification and analysis of labor in all producing centers and in addition listing the indirect labor of service departments. Analysis is accomplished by sorting the daily time tickets according to subclassifications.

- 1 For direct and indirect labor
- 2 By processes and service departments

Thus in a cotton mill all payroll checks are charged to Payroll Accrued account. At the end of the month a labor distribution sheet is prepared showing all labor applicable to the operations of the month whether paid or accrued. A distribution journal entry is then made debiting the various process accounts for direct labor, also debiting the process accounts and service department accounts for indirect labor, and crediting Payroll Accrued.

Detailed analysis of labor cost required in anthracite mining is explained by Mengel (N A C A Bulletin vol 22)

- |                        |                         |
|------------------------|-------------------------|
| 1 Cutting and loading  | 5 Drainage              |
| 2 Yardage and deadwork | 6 Ventilation           |
| 3 Haulage              | 7 Breaker (preparation) |
| 4 Timbering            | 8 Supervision           |

Eighty per cent of the working force is employed underground. In a typical colliery they might be scattered over an area several miles long and one or more miles wide with six or eight veins being worked on different levels reached by shafts or slopes. The actual working area might be 4 000 to 6 000 acres, if laid out flat. Distance therefore becomes an important cost factor. The labor cost is determined by levels by sections and as far as possible by individual working places so that the cost of every car of coal from each individual place may be known.

Avery (N A C A Bulletin vol 22) shows a labor classification for open-cut mining as listed below. Labor summaries are prepared daily.

No	Classification	No	Classification
001	COAL SHOVEL	b	Ditching
a	Engineers	c	Laying Pipe
b	Oiler	d	Repairs to Pump
c	Pit Men	071	MINE OFFICE
d	Drilling and Shooting	a	Manager
e	Channel Machines	b	Clerks
f	Cleaning Off Coal	c	Option Expense
g	Tractors	081	GENERAL
h	Repairs Coal Shovel	a	Superintendent
i	Repairs Tractors	b	Master Mechanic
021	HALLAGE	c	Electrician
a	Motorman and Engineers	d	Mechanists
b	Trip Rods and Bial emen	e	Blacksmith and Helpers
c	Truck Shifters	f	Welders
d	Repairs	g	Yardmen
e	Locomotive Hostlers	h	Teamsters and Trucking
b	General Expense	i	Handling Supplies
031	PREPARATION	j	Carpenters
a	Tipple Boss	k	Land Reclamation
b	Pickers	l	Road Expense
c	Repairs	091	STRIPPING SHIFT No 1
d	Dumpers	a	Pit Boss
e	Washery	b	Engineers
f	Washery Water Supply	c	Oilers
g	Refuse Disposal	d	Ground Men
h	Dyers	e	Dillers
i	General Expense	f	Helpers
041	R R CUL LOG AND YARD EXP	g	Shooting
a	Weighman	h	Electrician and Helpers
b	Car Timmers	i	Water Boy
c	Car Pinchers and Droppers		STRIPPING SHIFT No 2
d	Maintenance		(Same as above)
e	Cleaning Railroad Cars		STRIPPING SHIFT No 3
f	General Expense		(Same as above)
051	POWER	OX1	ENGINEERING
a	Power Lines	a	Mine Engineers
061	DRAINAGE	b	Wheelers
a	Pump Men	c	Prospect Engineering

In common with many other mining companies time tickets are not used employees' time being recorded on daily time sheets, summarized semi-monthly Says Avery

The account classification of the payroll summary is identical with the daily cost statement The summary of payroll is used as the basis for making the semi-monthly postings to the general ledger, and serves as a control for the labor costs in the daily cost statement and for the semi-monthly payroll from which the employee's pay check is determined

The daily time sheet in addition to furnishing the original data for the daily cost statement posted from the daily report sheet contains the information from which individual time reports are made for each employee for the periods running either from the 1st to the 15th or from the 16th to the end of the month

**MANUFACTURING EXPENSE PROCESS COST**—Manufacturing expense under a process cost system is collected, distributed, and



PRODUCTION COST SUMMARY  
BREAD DEPARTMENT

	Actual Cost Total	Actual Cost per 100 lbs Bread	Cost per 100 lbs Bread Required
Wrapping Wages	\$ 257 47	\$ 0771	\$ 065
Wrapping Supplies	747 45	2237	21
Wrapping Total	\$1 006 92	\$ 3008	\$ 275
Wages—Miscellaneous Foremen	627 72	1754	1475
Direct Shop Labor	1 729 83	4833	42
Wages—Miscellaneous Help	205 93	0575	05
Wages—hiremen	113 11	0316	025
Wages—Janitor	264 05	0737	050
Shop Labor—Total	\$2 940 64	\$ 8215	\$ 6025
Janitors' Supplies and Expense	17 25	0048	005
Steam Fuel	66 75	0186	035
Oven Fuel	152 43	0426	0425
Light and Power	247 12	069	055
Ice Refrigerant and Water	157 58	044	035
Shop Supplies and Miscellaneous Expense	34 81	0097	015
Building Repairs	16 28	0045	025
Machinery Repairs	6 09	0017	035
Oven Repairs	4 26	0012	005
General Repairs	60 41	0169	0125
Depreciation of Buildings	171 70	048	04
Depreciation of Pans	45 67	0128	015
Depreciation of Ovens	313 92	0877	035
Depreciation of Machinery	460 88	1288	12
Depreciation of Factory Furniture and Equipment	8 15	0023	002
Fire Insurance	14 12	0039	004
Liability Insurance	32 96	0002	005
Total Production Cost	\$4 740 02	\$1 3207	\$1 2215
Total Product Wrapping Cost	5 755 94	1 6081	1 50
Bread Wrapped (lbs)	334 069		
Bread Wrapped %	93 32		
Bread Sliced (lbs)	173 686		
Bread Sliced %	48 52		
Total Bread Produced (lbs)	357 644		

FIG 5 Labor and Expense Summary

applied to the product in the same manner as under any other system. If only one product is manufactured all actual expenses, analyzed by processes, are automatically charged to it. Examples of this type of overhead charging are found in baking industry, breweries, sulphur mining, coal mining, etc.

Where several products are produced simultaneously or in successive runs, overhead may be charged to products by

- 1 Apportioning, on some convenient basis actual expenses within each process to products worked on
- 2 Use of predetermined departmental expense rates. The use of such rates has the effect of averaging costs over all products and special care must be used in selecting the method of overhead apportionment

**Overhead for Single Product Industries.**—Plants producing only one product collect overhead in the usual way and transfer it to Work in Process. If there is more than one process overhead is distributed to each process on some equitable basis. Indirect material and indirect labor are easily distributed by means of information contained on requisitions, time tickets, etc. Other expenses both fixed and variable are distributed on the basis of weight, gallonage, number of units, etc.

Fig 5 suggested by Ulrich (N A C A Bulletin, vol 16) illustrates the simplest case of overhead application that of a bakery. All expenses are charged to bread making without any attempt at a subdivision of costs. The form is also used as a labor and expense summary.

In the list below is shown an expense classification for supplies and expenses in open-cut mining as set forth by Avery (N A C A Bulletin vol 22). Note that in this case expenses are analyzed departmentally.

No	Supplies Classification	No	Supplies Classification
012	COAL SHOVEL	002	DRAINAGE
a	Explosives for Coal	a	Pipe
b	Repairs Coal Shovel	b	Repairs
c	Supplies Coal Shovel	072	MINE OFFICE
d	Repairs Coal Drilling Tools	a	Rent Telephone and Telegraph
e	Repairs to Tractors	b	Stationery Printing and Postage
f	Other Supplies and Expense	c	Traveling Expenses
022	HAULAGE	d	Sales Expense
a	Supplies for Locomotives	042	ENGINEERING
b	Fuel for Boilers or Engines	a	Mine Engineer's Supplies
c	Steel Rails	b	Chemical Supplies
d	Track Fastenings	c	Prospecting
e	Repairs	082	GENERAL
f	Lubricants	a	Automobile Expense
032	PREPARATION	b	Shop Supplies and Expense
a	Repairs—Tippie	c	Welding Supplies
b	Repairs—Washing Plant	d	General Electrical Expense
c	Repairs to Refuse Disposal	e	Land Reclamation
d	Supplies Washery	f	Compensation Insurance
e	Dryer	g	Taxes
042	RK CAR LRG AND YARD EXP	h	Road Expense
a	Repairs	002	STRIPPING
052	POWER	a	Lubricants for Shovel
a	Power Purchased	b	Purchased Explosives
b	Power Lines		

**Actual Overhead for Multi Product Plants**—An example of the application of actual costs to production where a plant manufactures a variety of products is found in tanneries. Stevenson and Slack (N.A.C.A. Bulletin vol 14) describe the method as follows:

When all charges have been accumulated for the period the total of each operating account is listed on a work sheet called the 'big sheet'. At this time power is distributed to the departments which require power of any kind. The service departments—Switching, Jan and Hide House—are next closed out to other departments. Leach house costs are then assembled and charged into the Liquor Inventory Account after which the tanning liquor usage for the period is charged into the operating departments. General department is then distributed to the operating departments on the basis of net occupied because the processing of any one department is equally as important as that of another.

The expenses for each of the 11 operating departments are then assembled and the costs are ready for prorating to the individual days work.

**Predetermined Rates for Multi-Product Plants**—Use of applied expense rates in the case of multi product plants has steadily grown in recent years. This is due to the following reasons:

- 1 Application of overhead through applied rates is easier than through prorating of actual expense.
- 2 Applied rates may be in the form of standard rates thus affording an index of efficiency by comparison of actual and absorbed overhead.
- 3 Costs may be computed at any time, instead of only at end of month.

The computation of rates is accomplished in three steps:

- 1 Classification and accumulation of expenses on an estimated basis.
- 2 Distribution of expenses departmentally for this purpose expense distribution sheets are used. The service departments are closed out and producing department totals obtained.
- 3 Reduction of departmental expense totals to a rate to be applied to production. For this purpose any suitable base may be used such as unit of productive output direct labor cost direct labor hours machine hours product hours etc.

Halligan (N.A.C.A. Bulletin vol 19) favors use of the direct labor cost basis in the manufacture of mechanical rubber products, but excludes certain expenses from the departmental totals e.g., royalties paid for the use of machines or processes and mold depreciation both of which are treated as separate items of factory cost and applied specifically to products benefited. (For an evaluation of the relative merits of different methods of overhead application, see Section 19.)

**Standard Rates in Process Accounting**—A simple and interesting method for overhead control in a cotton mill through standard overhead rates is given by Bennett (N.A.C.A. Bulletin vol 21). All mill expenses are charged to the necessary expense accounts. The balances in these accounts are kept open until the end of the year. However a monthly entry is made as follows:

	(1)		
Mill Burden Variance Account		\$	
Mill Burden Clearing Account			\$
To transfer monthly to a variance account in amount equal to the sum of the open balances in the individual mill burden accounts			
	(2)		
Mill Burden Clearing		\$	
Sundry Mill Burden accounts			\$
To close annually balances in mill burden accounts			
	(3)		
Wool in Process		\$	
Mill Burden Variance			\$
To charge production at standard overhead rates			

The Mill Burden Clearing account is thus a suspense item. By means of these entries the expense accounts and the Burden Clearing account are closed. The Burden Variance account has been debited for actual expenses and credited for applied expenses. The balance shows over- and underapplied expense. The rates used by Bennett are based on labor cost which, however, under the peculiar conditions of cotton mill operations have the effect of machine hour rates. The total direct labor payroll for the week is divided among the products on the basis of expended carding hours, to obtain the labor cost of carding each product. According to Bennett

It was also found that if the burden of the department was applied as a percentage of the direct labor cost of each product as determined in accordance with the preceding formula the result is the equivalent of a machine hour rate with none of its complications and with all the simplicity of application and control that is inherent in the percentage of direct labor method.

**ANALYSIS OF MANUFACTURING COSTS**—The wool of cost analysis is facilitated by use of a distribution sheet. Accounts are listed down the page, producing and service departments across the page. This is similar to an expense distribution sheet, but in process costing all elements of cost are included since they constitute direct charges to the product and are not broken up by job orders. Dixon (N. A. C. A. Bulletin vol 1a) shows such a distribution sheet (Fig. 6) for a bitewey. In effect this becomes a cost sheet for the product.

A variation of this idea is in the form of an analysis journal (Fig. 7) used by a plate glass manufacturer and explained by H. H. H. (N. A. C. A. Bulletin vol 21). A separate sheet is used for each producing department. The figure shows the top part of the sheet providing for collection of charges to the indicated divisional costs. Fig. 8, containing a portion of the lower half of the analysis journal sheet shows the distribution of the general charges and indicates the bases of distribution. The section on the right headed "General Charges" is one of eight columns on the complete form for recording and applying direct and general charges to production. The analysis sheets are arranged to provide cost data by divisions or by items within a division. Where several products are involved direct charges are posted to each product while general charges are accumulated and then prorated to the products on a variety of bases. Several service departments appear on a single analysis sheet, each department being represented by a separate column.

## EXPENSE CLASSIFICATION

	General Plant 200	Power Plant 300	Brewery 400	Racking Room 500	Bottling House 600	Delivery 700	Selling 800	Adminis- trative 900
01 to 10—Raw Materials								
Variable								
01 Okech Malt			X					
02 Caramel Malt			X					
03 Other Malt			X					
04 Rice			X					
05 Grits			X					
06 Domestic Hops			X					
07 Imported Hops			X					
08 Other Raw Material			X					
09 Grain Sales (Credit)			X					
10 Cans and Labels			X	X				
21 to 29—Salaries and Wages								
Variable								
21 Departmental Labor	X	X	X	X	X	X		
22 Repair Labor Cases				X				
23 Repair Labor Coopers	X			X			X	
24 Office Salaries								X
25 Salesmen's Salaries								
Fixed								
27 Executive Salaries	X							X
28 Superintendence	X	X	X	X	X	X	X	X
29 Repair Labor—Buildings and Equipment	X	X	X	X	X			X
31 to 39—Supplies								
Variable								
31 Water	X	X	X	X	X	X	X	X
32 Purchased Power	X	X	X	X	X	X	X	X
33 Fuel	X	X	X	X	X	X	X	X
34 Repair Materials Cases				X	X			
35 Repair Materials Coopers	X		X	X	X			
36 Miscellaneous Supplies	X	X	X	X	X	X	X	X

	General Plant 200	Power Plant 300	Brewery 400	Reeking Room 400	Bottling Room 600	Delivery 700	Selling 800	Admin- istrative 900
Line 1								
37								
38								
39								
40 to 59—Miscellaneous Expense								
Variable								
40 Compensation Insurance								
41 Beer Lost and Consumed								
42 Bottle Breakage								
43 Cullet Sales (Credit)								
44 Case Depreciation								
45 Trucks Hired								
46 Advertising								
47 Telephone and Telegraph								
48 Travel								
49 Miscellaneous Freight and Cartage In								
50 Miscellaneous Expense								
Fixed								
51 Donations								
52 Dues and Subscriptions								
53 Professional Service								
80 to 89—Fixed Charges								
Fixed								
80 Real Estate Taxes								
81 Personal Property Tax								
82 State Franchise Tax								
83 Federal Permit Fee								
84 Insurance								
85 Interest on Investment								
86 Depreciation—Buildings								
87 Depreciation—Equipment								

Fig. 6 Departmental Cost Analysis









Where inclusion of raw material and direct labor is inadvisable the process distribution sheet becomes an **expense distribution sheet** and is handled in the usual manner.

**PROCESS COST SHEET**—Process cost sheets are often more complex and more formal than job order cost sheets because the former must show costs and quantities by departments. Often the process distribution sheet is used as a cost sheet. Gillespie (Introductory Cost Accounting) shows a form of distribution sheet (Fig. 9) which serves as a means of accumulating, and distributing factory expense, and transferring process costs.

Fig. 10 shows a cost sheet for a coal mining company which serves as a **production cost report**, since there is only one product and production is continuous. The report shows elements of production cost, production data, and various operating statistics.

**PRODUCTION BY SUCCESSIVE RUNS**—In some plants production is intermittent, not continuous. In such cases the product is processed in successive runs. This is in effect a combination of job order and process costing. It is job order costing in the sense that each run is represented by a production order and costs are accumulated thereon, and process costing because costs are gathered for each process. The method is found in automobile plants, canneries, bottling works, bakeries, etc. The reasons for successive runs are:

1. Exercise of a certain freedom of choice on the part of customers, as in the purchase of an automobile. The customer has a choice of body style, color, upholstery, accessories. All similar choices are therefore gathered into a single order for processing.
2. Lack of sufficient demand to make additional plant facilities economically feasible. Where the same machinery can be used to turn out a variety of products, such products are produced in rotation unless demand is such that additional facilities make possible continuous runs on each product.
3. Seasonal and climatic conditions.

**Accounting for Successive Runs**—Blocker (Cost Accounting), in discussing vegetable canning costs, says:

The general ledger journal entries are the same in this type of processing as in the procedure explained for a factory or process producing a single product in a continuous manner. Material, labor, and factory overhead expenses are charged to each process at the end of each accounting period. The difference lies in the use of subsidiary records. A separate analysis sheet is prepared for each run to show the material, labor, and factory costs which can be definitely identified with the vegetable being processed. Likewise the number of hours that the equipment is used for each vegetable and the total production of cans are carefully recorded. At the end of each accounting period labor costs and factory overhead expenses which cannot be identified with a separate run are allotted to the production of each vegetable, usually on a single distribution base.

Amidon and Lang (Essentials of Cost Accounting) exhibit a comparative cost sheet for ginger ale in a plant manufacturing a variety of soft drinks (Fig. 11). Note that **predetermined expense rates** are used in charging overhead to product. Blocker advocates the distribution of actual overhead, thus delaying cost determination on each run until the

C O S T							
LABOR DISTRIBUTION			THIS MONTH		YEAR TO DATE		
DIVISION		CLASSIFICATION	A	P	T	A	
STRIPTIME	11	Pl and O l d A C					
	1	OH					
		TOTAL					
INSIDE	CONCT	1	D l d B l l l A C				
			Qth D f d A C				
		23	C l l M l g				
		24	C l l Tmb l g				
		5	C l l D l l g				
		TOTAL					
	CON Y	13	M l —D y H l				
		3	L M g				
		23	V M H				
		24	T p f l				
		15	P m p l g				
		5	Tmb l g				
		17	M l l H g				
			TOTAL				
TOTAL INSIDE							
OUTSIDE		61	T p l l				
		62	P p l				
		63	R f D p l				
		64	Tmb Y d				
		65	St bl (D l d O l y l)				
		66	St K C l				
		67	B l l d P r P l l				
		68	St l l l g				
		69	C p a t g				
		610	M M l e l				
		611	D l l				
		TOTAL					
SUPERVISION	1	St l p p l g					
		1 Id					
	73	O l l d					
	74	OB					
	75	O c a l O r b d					
	TOTAL						
TOTAL LABOR COST							
MATERIAL AND EXPENSE DISTRIBUTION							
	16	St l p p l g					
	11	Id					
	12	O l l d					
	13	C M y G l					
TOTAL MAT L AND EXPENSE							
GRAND TOTAL PRODUCTION COST							

FIG 10 Monthly Process

PRODUCTION DATA						
		THIS MONTH		YEAR TO DATE		
		T	P	T	P	
REDUCTION TONNAGE BY METHODS	ORE					
	N					
	TOTAL PELLETS					
	1					
	2					
TOTAL STEAM						
GRAND TOTAL						
ROILER FUEL	Oil					
	Gas					
TOTAL						
STOCK COAL	ORE					
	N					
	2					
	3					
	4					
TOTAL						
L REQUIRE P AN N	1 p d l					
	2					
TOTAL						
TYPE STOCK	Oil					
	Gas					
	Oil					
	Gas					
DISTRIBUTION	Oil					
	Gas					
TOTAL						
MINERAL FUEL	Oil					
	Gas					
	Oil					
	Gas					
	Oil					
	Gas					
	Oil					
TOTAL						
TONNAGE AND COST SUMMARY						
MONTH	TONS		COST		YEAR TO DATE	
	THIS MONTH	YEAR TO DATE	THIS MONTH	YEAR TO DATE	T	P
J						
P						
M						



COMPARATIVE COST SHEET								
Product <i>Singer Apples</i>								
Number of Run	951		955		963			
Date Started								
Date Completed								
Quantity Processed								
Labor Hour (Laboratory)								
Machine Hours (Bottling)								
Operating Costs	Total	Unit	Total	Unit	Total	Unit	Total	Unit
Laboratory								
Flavors								
Direct Labor								
Applied Expense								
Total								
Sugar Syrup								
Carbonated Water								
Bottling								
Direct Labor								
Applied Expense								
Total								
Total Cost of Run								

FIG 11 Process Cost Sheet for Successive Runs

end of the month. With applied expense rates, costs are determined within 24 hours after the run is completed.

The basis for charging overhead to product, whether actual or pre-determined, is the same as in any other system. Fig 11 employs labor hours in the laboratory, machine hours in the bottling process. Blocker suggests for canneries any of the following:

1. Production hours for each vegetable
2. Number of cans of each vegetable produced
3. Number of pounds of each vegetable packed

Fig 12, suggested by Blocker (Cost Accounting), shows a monthly cost report for a vegetable cannery.

Since No. 2 cans were the only size used, unit costs were computed on the basis of the number of cans produced. If vegetables had been packed in several different sized cans, the unit cost determination could have been made on the basis of the number of pounds packed.

**Moving Average Unit Product Cost**—Because of climatic and other special conditions, true unit costs cannot be obtained in some industries from any one run or production order. The output is affected by causes beyond the control of the personnel and hence wide variations in production costs occur. While this condition applies to a considerable

## ANALYSIS OF COST OF PRODUCTION

JUNE 1 TO JULY 1 19—

Production Expenses	Asparagus		Peas		Beans		Spinach		Total Costs
	Cost	Cost per Unit	Cost	Cost per Unit	Cost	Cost per Unit	Cost	Cost per Unit	
Materials									
Vegetables									
Cans and Lids									
Labels									
Boxes									
Miscellaneous Supplies									
Total Material Costs	\$1 194 00	\$0 0796	\$2 316 00	\$0 0579	\$ 938 00	\$0 0469	\$2 850 00	\$0 0507	\$ 7 298 00
Labor									
Direct Labor Payroll									
Supervision Payrolls									
Total Payroll Costs	\$ 600 00	\$0 04	\$1 000 00	\$0 025	\$ 400 00	\$0 02	\$2 000 00	\$0 04	\$ 4 000 00
Factory Overhead Expenses	300 00	0 02	600 00	0 015	400 00	0 02	600 00	0 01	1 800 00
Total Costs	\$2 094 00	\$0 1396	\$3 916 00	\$0 0679	\$1 738 00	\$0 0609	\$5 350 00	\$0 107	\$13 098 00
Total Production, No 2 Cans	15 000		40 000		20 000		50 000		125 000

Fig 12 Monthl Cost Report for Successive Runs

number of industries, it is well illustrated by the case of a pharmaceutical manufacturer:

To produce serum, it is often necessary to inoculate animals over a period of months. While the same effort and expense is put forth the finished product or usable serum is seldom the same. A similar condition exists in the production of pills or tablets for medicinal purposes. Climatic conditions cause wide variances in the finished product. If the unit cost of any one run were accepted it would not be a fair cost. Therefore a number of runs are used in arriving at an average unit cost. As a new run is added an old one is dropped, thereby keeping a current average. To illustrate the average unit cost method the following table is presented:

Run	Raw Materials Put into Production		Direct Labor	Burden	Total Factory Cost	Yield in Lbs	Cost Per M
	Quantity	Value					
1	1 000 lbs	\$2 000	\$200	\$ 300	\$ 2 500	800	\$8 125
2	500	1 000	100	150	1 250	500	2 500
3	1 000	2 000	200	300	2 500	500	2 777
4	500	1 000	100	150	1 250	375	3 333
5	1 000	2 000	200	300	2 500	700	3 571
	<u>4 000 lbs</u>	<u>\$8 000</u>	<u>\$900</u>	<u>\$1 200</u>	<u>\$10 000</u>	<u>3 275</u>	<u>\$8 053</u>

The average unit cost for cost purposes is \$3 053 a thousand. When run 6 is put through, the cost of run 1 is dropped and that of run 6 is added. A new average is obtained and governs until a new run is put through.

The average unit cost method is applicable to any condition where manufacturing processes are beyond the control of the management because of natural laws.

**CLOSING JOURNAL ENTRIES**—From a bookkeeping point of view, the chief difference between job and process costing, lies in the handling of the Work in Process account or accounts. Subsequent to the work in process stage, the accounting for Finished Goods and Cost of Sales is the same in any system. In process costing the general scheme is to transfer charges from process to process until the transfer to Finished Goods is effected. To facilitate the monthly closing of process accounts a process cost sheet is often used. Fig 9, shown earlier in this section, thus serves as a basis for preparing:

1. Redistribution of service department charges
2. Closing entries
3. Transfer of costs from process to process
4. Operating statements without the necessity of referring to the ledger accounts

In transferring process costs it is important to have the accounts arranged on the process cost sheet and the process ledger in the order in which the operations are performed. In this way a continuous chain of entries results, charging the succeeding process and crediting the prior process. This closing procedure is illustrated in the manufacture of plate glass as described by Harold (N A C A Bulletin vol 21).





- 1 Charging rough flat glass stock with the net production and cost of operation of the tank department and crediting the tank department
- 2 Charging the grinding and polishing department with footage and value of rough flat glass stock laid and crediting rough flat glass stock account
- 3 Charging uncut stock with footage and value of glass ground and polished plus cost of departmental operations, and crediting the grinding and polishing department account
- 4 Charging the factory glass unit in the warehouse department with the footage and value of glass taken from uncut stock and crediting uncut stock account
- 5 Charging the finished flat glass stock account with the footage and value of glass taken from uncut stock plus cost of operation of the factory glass unit and crediting the warehouse department account
- 6 Charging glass transferred from semi finished and finished stocks to proper accounts, and crediting respective stock accounts
- 7 Charging general office with glass used for samples loss on cutting orders and loss in finished flat glass stock and crediting semi finished and finished stocks so affected

A somewhat different scheme is found in manufacture of hatter's fur, monthly closing entries are based on daily figures obtained from daily reports and accumulated in an analytical journal (Fig 13)

Instead of transferring charges from one work in process stage to another, only conversion costs are recorded in each process and all such process costs are then closed to a single Work in Process account. This procedure is explained by Venman (N.A.C.A. Bulletin vol 17). The columns on the summary sheet (Fig 13) are totaled and the following journal entries result

	(1)	Acct No		
Work in Process		420	\$	
Purchases—skins		420		\$
Opening		431C		
Clipping		431D		
Carroting		431E		
Cutting		431F		
To close process conversion costs to Work in Process				

	(2)	
Cut Fur	440	
Pelt	441	
By Products	442	
Work in Process	430	
To transfer to finished production the value of cut fur and of various by products		

	(3)	
Work in Process—Blown Fur	432	
By Products	442	
To charge value of by products used to Work in Process		

	(4)	Acct No
Work in Process—Blown Fur		432
Cooling		431G
Blowing		431H
To charge labor and expense in processing blown fur		
	(5)	
Blown Fur		443
Work in Process—Blown Fur		432
To transfer cost of blown fur to finished production		
	(6)	
Cost of Sales—Cut Fur		450
Cost of Sales—Blown Fur		451
Cost of Sales—Pelt		452
Cost of Sales—By Products		453
Cut Fur		440
Blown Fur		443
Pelt		441
By Products		442

To record cost of products sold

Any balances left in above accounts other than Cost of Sales represent closing inventories. Supplies and joint departmental expenses are closed each month as they would be under any other system. The figures for such closing are obtained from the departmental expense distribution sheets.

## Unit Costs and Effective Production

**COMPUTING UNIT COSTS**—In its simplest form a unit product cost is determined for each process on the basis of material, labor, and overhead incurred in that process for a given production. Thus in a foundry, the cost per pound of metal at the spout is found on the basis of the following formula as explained by Robinson (N A C A Bulletin vol 11)

$$C = \frac{M + L + O}{W}$$

where  $C$  = Cost per pound at spout

$M$  = Value of net charge weight of metal and raw materials

$L$  = Cost of cupola direct labor

$O$  = Overhead cost found as percentage of direct labor

$W$  = Gross weight in pounds of metals less recoveries i.e. castings plus losses

Where the same facilities are used to turn out more than one product unit costs are obtained either by

1. Proportion formulas or

2. Introduction of job order technique to insure segregation for material and labor. In such cases overhead is charged on the basis of predetermined rates.

Jones discussing costs in the manufacture of sparkling soft drinks (N A C A Bulletin, vol 17) illustrates the last method.

It was desired that accurate unit costs be obtainable easily by flavors and sizes. The accounts were therefore so subdivided that the

basic data for these calculations were readily obtainable. Discrimination must be exercised to choose only those factors which cause appreciable variations in order that the cost of getting the information may not exceed its useful value.

**Proration** is illustrated in the manufacture of plate glass. The batch department mixes raw materials and feeds them to the tank department. Proration of batch department costs is determined by tank production of each thickness of glass (according to Hunsold (N.A.C.A. Bulletin vol. 21)).

When only one thickness of glass is produced during a month the total weight and total value of mixed batch and the total cost of the tank department are applied against the net production of glass recorded at the examining end of the year. If more than one thickness is produced during a month the total weight and value of the batch are distributed to each thickness of glass produced on a weight basis. The weight of each thickness is determined by reducing all thicknesses produced to a common thickness and then using a common unit weight per square foot.

The tank department costs are prorated to each thickness on the basis of the number of hours the tank operated on each. A similar formula is used in the grinding and polishing department.

From the formulas given above, unit costs can be computed provided the cost figures as well as the production figures are available. However, the existence of **work in process** at the beginning or end of the period necessitates a refinement of the above method of costing. Since a part of the cost incurred applies to units still in process the total cost cannot be charged to units finished or transferred to another department for further processing. Costs must be spread over all the work of the department. Hence the production report figures are inadequate for this purpose for two reasons:

- 1 The production report covers only the physical movement of goods from process to process. It includes inventories in process at the beginning of a period which were at least partially completed in a prior period.
- 2 The production report does not include inventories in process at the end of a period on which some work has been done.

**EFFECTIVE PRODUCTION DEFINED**—To obtain correct unit costs it is necessary to spread the total costs over all work done in a department, both completed and uncompleted. To accomplish this the work of the department must be expressed in terms of a common denominator, referred to as the effective production. The latter sometimes referred to as equivalent production represents the total work of a department or process in terms of **fully completed units**. This idea rests on the assumption that the work in producing 100 units of product one half completed is equivalent to 50 units full, completed.

**Stage of Completion**—To obtain a figure for effective production, complete information must be available as to the stage of completion of both opening and closing inventories. In extreme cases the stage of completion figures must be given separately for material, labor, and overhead. If all material is issued at the beginning of a process the full material cost must be charged to inventory, as for labor and overhead inventory may be only partially completed depending on the length of

processing time, hence only a portion of labor and overhead costs must be charged to the inventory. If material, labor, and overhead are consumed uniformly throughout the process, a single computation of effective production suffices.

**Methods of Computing Effective Production**—There are two formulas for computing effective production. The first is similar to the cost of sales formula for a trading concern. All figures except the final one are expressed in terms of incomplete units, that is, units on which no work at all has been done. Thus:

#### Method I Inventory Method

- 1 Inventory at beginning equivalent incomplete units
- 2 Add Quantity Put into Process
- 3 Total Incomplete Units Handled
- 4 Less Inventory at end equivalent incomplete units
- 5 Effective Production (equivalent completed units)

The second method analyzes the work of a period for each stage of a department's work in terms of fully completed units.

#### Method II Completed Units Method

- |   |                                  |
|---|----------------------------------|
|   | Equivalent<br>Completed<br>Units |
| 1 Inventory at beginning work needed to complete during current period (found by applying percentage to units in initial inventory) |                                  |
| 2 Units started and finished during current period (number of new units started minus units in final inventory)                     |                                  |
| 3 Units started but not finished (percentage done on final inventory)   |                                  |
| 4 Effective Production  |                                  |

Both methods must give the same result. (See illustrations below.) There are three cases which call for different solutions in the determination of unit costs:

- CASE I No opening and no closing inventory of work in process  
 CASE II No opening inventory, but there is a closing inventory of work in process  
 CASE III Both opening and closing inventories are present

**Case I No Opening and Closing Inventories**—This presents no difficulties; unit costs are computed on the basis of actual production as in the following situation. Assume that in process A material costs are \$6,000, labor \$3,000, and expense \$3,000. The actual production is 10,000 units.

$$\text{Cost per unit} = \frac{\text{Total cost}}{\text{Quantity produced}} = \frac{\$12,000}{10,000} = \underline{\underline{\$1.20}}$$

PROCESS A			
Material	\$ 6 000 00	Transferred to B	\$12 000 00
Labor	3 000 00	(10 000 × \$1.20)	
Expense	3 000 00		
	<u>\$12 000 00</u>		<u>\$12 000 00</u>

**Case II Closing but No Opening Inventory**—In this situation where Work in Process shows a closing but no opening inventory it is necessary to compute the **effective production**. Assume the same facts as in Case I in addition the production records reveal the following information:

Completed and Transferred	Units 10 000
Inventory at end 40% complete	2 000

**Solution**

	Units
1 Effective Production (using completed units method)	
Started and finished	10 000
Inventory at end (2 000 $\times$ 40%)	800
Effective Production	<u>10 800</u>
2 Unit Cost	
$\frac{\text{Total cost}}{\text{Effective production}} = \frac{\$12\,000}{10\,800} = \$1\,111\,11$	
3 Inventory Value (2 000 $\times$ 40% $\times$ \$1 111 11)	\$ 888 80
4 Value of Transfer to Process B (10 000 $\times$ \$1 111 11)	11 111 11
Total credited to Process A	<u>\$12 000 00</u>

**PROCESS A**

Material	\$ 6 000 00	Transferred to B	\$11 111 11
Labor	3 000 00	Inventory	888 80
Expense	3 000 00		
	<u>\$12 000 00</u>		<u>\$12 000 00</u>
Inventory	\$ 888 80		

**Case III Opening and Closing Inventories Present**—Effective production must be computed where there are opening and closing inventories. The following case illustrates the procedure:

**PROCESS A**

Opening Inventory	\$ 200 00
Material	6 000 00
Labor	3 000 00
Expense	3 000 00

**Production data**

	Units
Opening Inventory 30% complete	500
Put into Process A	10 000
Transferred to Process B	9 500
Closing Inventory, 40% complete	1 000

**A Effective Production**

	Units
Opening Inventory 70% incomplete	350
Put into Process	10 000
Total Incompleted Units Handled	<u>10 350</u>
Less Inventory at end 60% incomplete	600
Effective Production	<u>9 750</u>

Method II may be employed to check the above result as follows

	Completed Units
1 Portion of opening inventory completed in current period (500 × 70%)	350
2 Started and finished during current period (10 000 - 1 000)	9 000
3 Portion of closing inventory completed in current period (1 000 × 40%)	400
Effective Production	<u>9 750</u>
<b>B Unit Current Process Cost</b>	
$\frac{\text{Total current costs}}{\text{Effective production}} = \frac{\$12\ 000}{9\ 750} = \$1\ 230\ 769$	
<b>C Closing the Process Account</b>	
1 Value of closing inventory (1 000 × 40% × \$1 230 769)	\$ 492 31
2 Total debits	12 200 00
3 Balance representing transfer to B	<u>\$11 707 69</u>
<b>D Proof of Charges Transferred to B</b> There were 9 500 units transferred to the next process. These represented costs incurred as follows	
1 Opening Inventory	
500 units cost incurred in prior period	\$ 200 00
500 units cost incurred in current period (500 × 70% × \$1 230 769)	430 77
2 Started and Finished in Current Period (9 000 × \$1 230 769)	11 076 92
Total Transfer to B	<u>\$11 707 69</u>

**COSTS IN SUBSEQUENT PROCESSES**—In computing costs for processes after the first one the general procedure is the same as for the first process, except that transferred costs must be added to **conversion or process costs** both for purposes of valuing the inventory and transferring to the next process. By **conversion cost** is meant the total of direct labor and manufacturing expense of a process. Manufacturing expense includes both direct charges and redistributed service department charges. If there are any credits applicable for labor and for expense net conversion costs only are used in arriving at unit costs.

**STEPS IN CLOSING PROCESS ACCOUNTS**—In closing process accounts the following steps must be taken

- 1 Compute effective production from given data
- 2 Calculate net conversion or net process cost
- 3 Compute unit conversion or unit process cost (item 2 divided by item 1)
- 4 Credit process account for value of closing Work in Process Inventory on the basis of
  - a Unit conversion or unit process cost taking into account stage of completion
  - b Full transferred unit cost
- 5 Balance of process account represents charge to be transferred to the next process or to Finished Goods

The following problem adapted from Amidon and Lang (Essentials of Cost Accounting) illustrates the entire process cost procedure

## PROCESS A

Inventory at beginning	\$ 200 00	Transferred to Process B	?
Material	8 000 00	Inventory at end	?
Labor	4 000 00		
Expense	2 900 00		

## PROCESS B

Inventory at beginning	\$1 430 00	Transferred to Finished Goods	?
Labor	5 000 00	Inventory at end	?
Expense	2 000 00		

## Production data

	Dept A		Dept B	
	Number of Units	Stage of Completion	Number of Units	Stage of Completion
Opening Inventory				
Material	500	30%		
Labor		50	1 000	70%
Expense		20		70
Put into Process	15 000		12 500	
Completed and forwarded to next department	12 500		13 000	
Closing Inventory				
Material	3 000	100		
Labor		40	500	80
Expense		10		80

No new material is added in process B. Below are presented the working papers: the complete ledger accounts and a process cost report.

## COMPUTATION OF EFFECTIVE PRODUCTION

	Physical Units	Material		Labor and Expense	
		% Incom- plete	Equivalent Unfinished Units	% Incom- plete	Units
PROCESS A					
Opening Inventory	500	70%	350	50%	250
Put into Process	15 000		15 000		15 000
Total Incomplete Units Handled	15 500		15 350		15 250
Less Inventory at end	3 000	0	-	00	1 800
Effective Production	12 500		15 350		13 450
PROCESS B					
Opening Inventory	1 000	0	-	30	300
Put into Process	12 500				12 500
Total Incomplete Units Handled	13 500				12 800
Less Inventory at end	500	0	-	20	100
Effective Production	13 000				12 700



## COST OF PRODUCTION

	DEPARTMENT A			DEPARTMENT B		
	Effective Quantity	Physical Quantity	Unit Cost	Effective Quantity	Physical Quantity	Unit Cost
1 Opening Inventory per ledger accounts						
2 Received from prior department						
3 Current Costs						
Material						
Labor						
Expense						
Total Conversion Cost						
4 Total Process Charges						
5 Less Inventory at end (See Schedule below)						
6 Cost of Goods Transferred						

## SCHEDULE OF CLOSING INVENTORY VALUES

## DEPARTMENT A

Material  $(3,000 \times \$ 521173)$ Labor  $(3,000 \times 40\% \times \$ 297398)$ Expense  $(3,000 \times 40\% \times \$ 215613)$ 

Total Inventory

## DEPARTMENT B

Material

Labor  $(500 \times 80\% \times \$ 393701)$ Expense  $(500 \times 80\% \times \$ 157480)$ Prior Cost  $(500 \times 100\% \times \$ 1,037,660)$ 

Total Inventory

\$ 1,563,52

356,88

258,74

\$ 2,179,14

\$

157,48

62,99

518,83

\$ 739,30

## PROOF OF COST OF TRANSFERS

## DEPARTMENT A

1 Opening Inventory		
Cost carried forward (500 units)		\$ 250 00
Cost to Complete in Current Period		
Material (500 $\times$ 70% $\times$ \$ 521173)	\$ 182 41	
Labor (500 $\times$ 50% $\times$ \$ 297398)	74 30	
Expense (500 $\times$ 50% $\times$ \$ 215613)	53 90	310 60
2 New Production Completed in Current Period		
Material (12 000 $\times$ \$ 521173)	\$ 6 254 09	
Labor (12 000 $\times$ \$ 297398)	568 78	
Expense (12 000 $\times$ \$ 215613)	2 587 35	12 410 21
3 Value of Goods Transferred to B		<u>\$12 970 87</u>

## DEPARTMENT B

1 Opening Inventory		
Transferred Cost carried forward		\$ 1 430 00
Cost to Complete in Current Period		
Labor (1 000 $\times$ 30% $\times$ \$ 393701)	\$ 118 11	
Expense (1,000 $\times$ 30% $\times$ \$ 157480)	47 24	165 35
2 New Production Completed in Current Period		
Material (12 000 $\times$ \$ 393701)	\$ 4 724 41	
Expense (12 000 $\times$ \$ 157480)	1 880 70	
Transferred from A (12 000 $\times$ \$1 037669)	12 452 03	10 060 20
3 Value of Goods Transferred to Finished Stock		<u>\$20 661 55</u>

## Completed Ledger Accounts

## PROCESS A

Inventory at beginning	\$ 250 00	Transferred to B	\$12 970 80
Material	8 000 00	Inventory at end	2 170 14
Labor	4 000 00		
Expense	2 900 00		
	<u>\$15 150 00</u>		<u>\$15 150 00</u>
Inventory	<u>\$ 2 170 14</u>		

## PROCESS B

Inventory at beginning	\$ 1 430 00	Transferred to finished Goods	\$20 661 50
Labor	5 000 00	Inventory at end	739 30
Expense	2 000 00		
Transferred from A	12 970 86		
	<u>21 400 86</u>		<u>\$21 400 86</u>
Inventory	<u>\$ 739 30</u>		

In this solution opening and closing balances in inventories are not analyzed as to their material, labor overhead and transferred cost content. This can be done if desired, in fact separate process accounts may be opened for each element of cost. An example of such detailed analysis is shown in Fig 14 taken from Dohi, Ingham, and Love (Cost Accounting)

			Rate Per Finished Unit		
<b>GOODS IN PROCESS, DEBITS</b>					
Opening Inventory 100 Units					
Materials	50% Complete as to Cost (50 Unfinished)	Equivalent to 50 Units Finished	\$1.20	\$60.00	
Labor	40% Complete as to Cost (40 Unfinished)	Equivalent to 40 Units Finished	1.25	50.00	
Factory Service	40% Complete as to Cost (40 Unfinished)	Equivalent to 40 Units Finished	2.00	80.00	\$190.00
			<u>\$4.45</u>		
Charges for the Period 5,000 Additional Units put into Process					
Materials				\$6,200.00	
Labor				7,200.00	
Factory Service				10,500.00	23,900.00
<b>TOTAL DEBITS</b>					<u>\$24,090.00</u>
<b>GOODS IN PROCESS, CREDITS</b>					
Final Inventory 150 Units					
Materials	100% Complete as to Cost	Equivalent to 150 Finished Units @	\$1.22772	\$184.16	
Labor	80% Complete as to Cost	Equivalent to 120 Finished Units @	1.43141	171.77	
Factory Service	80% Complete as to Cost	Equivalent to 120 Finished Units @	2.08748	250.50	\$606.43
			<u>\$4.74661</u>		
Finished Units 4,950 Units Transferred to Next Process (or to Finished Goods)					
Materials	4,950 @		\$1.22745	\$6,075.84	
Labor	4,950 @		1.47903	7,308.23	
Factory Service	4,950 @		2.08077	10,300.50	21,484.57
			<u>\$4.78725</u>		
<b>TOTAL CREDITS</b>					<u>\$24,090.00</u>

FIG. 14 Detailed Process Inventory Analysis

**SHORT-CUTS FOR VALUING WORK IN PROCESS**—The method outlined in the preceding pages for the proper costing of work in process is somewhat cumbersome, but is undoubtedly accurate. Williams (N.A.C.A. Bulletin, vol. 5) proposes a short-cut by doing away with work in process inventories at the end of a period. He describes a procedure for a foundry consisting of foundry, machining, polishing, cleaning, packing, storage and shipping departments. Production being continuous there is always a large number of articles on hand in every stage of completion. The physical production turned out by the foundry department in the course of a month forms the basis of cost calculation. Production orders are issued for maximum quantities only. At the end of the month there is entered as the quantity to be produced the same quantity that was processed through the first operation. Williams states:

In closing the November accounting we had December labor and overhead charged to November costs and appearing in the November inventories but this was offset by the item of accrued payroll and the credit to the expense distribution account. When closing the cost orders all cards stamped November were posted as though the work had been done in November but the regular December cards were posted to the cost sheets for the month of December. By this method, on the 5th of December every cost sheet for November showed only completed work and the laborious task of getting costs on partially completed work was done away with.

Another suggestion for shortening the work comes from Schlatter (Elementary Cost Accounting) who advocates omission from consideration of work in process inventories provided

- 1 Amount and value of work within a process at the end of a period are small when compared to the total amount and value passing through the process in a given period
- 2 Amount and value of work in process inventory are constant i.e. remain approximately the same

In such cases he states

The inventory may be ignored without materially affecting the reliability of unit cost figures. But if the variation in amount is considerable and the value is high the inventory must be given consideration because to ignore it would seriously affect the reliability of the unit cost figures.

In support of this theory Mengel discussing work in process in anthracite mining (N.A.C.A. Bulletin, vol 22) states

This is a term practically unknown in anthracite. Although today some labor materials and power are expended in loading a mine car that may not reach the surface until tomorrow no attempt is made to set this up against tomorrow's cost because yesterday the same thing happened. The end of each working day completes a cycle which started yesterday or before but which is fairly constant day by day.

**Elimination of Work in Process Account**—If a plant manufactures only one product by a single process there may be no work in process inventory, since the product is either still in the raw material stage or else is finished. This is especially the case where the product takes less than 24 hours to complete. Examples are bread making sulphur mining, etc. In such cases, a Work in Process account is not even necessary, since all costs can be charged to a Cost of Production (i.e. Finished Goods) account. Adamson (N.A.C.A. Bulletin vol 15) states

We have no In Process inventory just as in the producing end of the oil business there is none. Sulphur either has been produced or it has not been produced. When melted it is pumped to the surface almost 100% pure and does not undergo any sort of treatment or processing whatsoever.

## Shrinkage, Waste, and Spoilage

**QUANTITY CONTROL**—In general the treatment of waste scrap and shrinkage follows the same lines as shown in Section 14. These matters are closely connected with the subject of quantity control and anything affecting quantity produces in effect on unit costs. Gillespie, discussing quantity control (Introductory Cost Accounting) states

Quantity control in process cost accounting refers to the maintenance of records of quantities for the purpose of detecting shrinkage breakage theft etc.

The cost department is charged with the duty of computing total and unit costs of production. In doing so quantities entering a process must be reconciled with quantities leaving the process, and the loss if any must be analyzed into those factors that are controllable and those that are noncontrollable. Complete quantity control reconciles raw material purchases with the flow of such materials through the manufacturing processes to finished goods and finally to sales.

**Quantity Control as Index of Efficiency**—One way of controlling quantities is to establish process yields. Material yields are computed by the cost department and reported regularly along with production cost data and reports. Such yields are ordinarily obtained in percentage form computed from the following formula:

$$\% \text{ Yield} = \frac{\text{Product yield}}{\text{Product input}}$$

Measurement for both quantities may be weight units or units of product. Yield formulas may be used as indexes of operating efficiency.

**Shrinkage Control**—Sometimes in place of a yield formula its converse is used showing a percentage loss of shrinkage. Thus material control in the baking industry, as stated by Henry (N A C A Bulletin, vol 20), is exercised to control losses due to the following causes:

- 1 Short weight packages having been received without detection
- 2 Shrinkage of material during storage
- 3 Material wasted
- 4 Material misappropriated

Fig 15 is a material cost summary for a bake shop to which have been added quantity control data including percentage losses. These losses cover the following items according to Ulrich (N A C A Bulletin, vol 16)

- 1 Loss (or gain) in scaling. This represents the difference between the weight of dough delivered to the divider or bench and the scaling weight of all units produced.
- 2 Invisible loss. This is the difference between formula weights and purchase weights. Formula weights represent standard allowances as shown on formula cards. This loss is due to a weight loss of flour and other materials during storage and to careless handling and scaling of materials. It is the difference between the actual and the formula or calculated weight of material entering into the doughs produced.
- 3 Fermentation loss. This is the difference between the weight of dough put into the trough and placed in the fermentation room and the weight of dough after fermentation (Item E minus item b Fig 15). Fermentation loss is controlled through maintaining proper temperature and humidity in the fermentation room.
- 4 Absorption. This is a term applied to the amount of water or liquid absorbed per 100 pounds of flour put into the mixers.

**ACCOUNTING FOR SHRINKAGE**—Many shrinkages are due to the nature of the operations and cannot be controlled. The most common method therefore in accounting for shrinkage is treatment by neglect. This means spreading process costs over the units obtained from process thus increasing the unit cost of those units which absorb the cost of shrinkage. For example Halligan discussing the manufacture of mechanical rubber products (N A C A Bulletin vol 19), states:

During these rubber handling operations there are distinct shrinkages due to the elimination of foreign matter which must be compensated for by increasing the pound cost of the remaining rubber. This shrinkage ranges from less than 1% to approximately 20%.

Similarly there are shrinkages in other compounding ingredients where it is necessary to make frequent tests for each type of material so that

MATERIAL COST SUMMARY  
BREAD DEPARTMENT

	Formula Weights	Purchase Weights	Cost Total	Actual Cost 100 lbs Bread	Cost 100 lbs Bread Required
101 Wheat Flour	202 861	206 712	\$5 339 06	\$1 4918	
102 Rye Flour	7 028	7 135	247 49		
103 W W Flour	0 826	7 056	217 56		
104 Dusting Flour	4 667	4 667	116 02		
Other Flour	18 521	18 858	581 67		
Total Flour	221 982	225 570	\$5 921 03	\$1 6541	
107 Sugar Syrup	6 841	0 777	\$ 320 36	\$ 0804	
108 Malt	1 916	1 018	115 03	0325	
109 Shortening	8 420	8 050	716 33	2001	
110 Powdered Milk	1 710	1 760	122 81	0343	
111 Condensed Milk	13 628	14,281	049 00	1813	
112 Liquid Milk					
113 Yeast	4 724	4,736	805 07	2249	
114 Yeast Food	783	677	35 79	61	
115 Salt	3 901	4 331	50 35	0141	
116 Pan and Divider Oil and Grease	313	313	21 23	0059	
117 Trough Grease	120	120	6 60	0027	
118 Finishing Materials	3 197	3 197	205 85	0575	
119 Other Ingredients	1 508	1 333	81 08	0227	
120 Absorption Boost oil	917	678	86 23	0241	
	269 366	274 241	\$9 140 06	\$2 5136	\$2 50

A	Total Weight of Materials	269 360
B	Less Dusting Flour etc.	8 177
C	Weight of Materials put in Mixer	261 183
D	Weight of Water put in Mixer	131 430
F	Weight of Water and Material	392 622
F	Weight of Dough Produced	301 503
G	Weight of Bread Produced	357 944
I	Total Bbls of Flour Used	1150 0
J	Average Yield per Bbl	311 61
K	Average Cost W Flour per Bbl	5 0634
	Loss or Gain Scaling	
	% Invisible Material Loss	1 77
	% Loss During Fermentation	285
	% Absorption	60 65
	% Pan Grease Used	1162
	% Dusting Flour Used	1 7326

FIG 15 Material Summary and Shrinkage Losses

the pound cost may be increased by a proper shrinkage factor to insure accuracy in the final product costs.

The same procedure is followed in taking up the shrinkage or loss in weight as a result of drying fabrics that are to be coated with rubber compound. The weight of the moisture eliminated is added to the pound cost of the dry fabric.

The same method is often applied in the treatment of **spoilage**. Thus in the clay products industry, costs are prorated over **No. 1 salable ware** which in this way absorbs the cost of defective and spoiled ware. Under this method no journal entries are required but each process must keep a record of shrinkage, spoilage, etc.

**Separate Costing of Shrinkage, Spoilage, Etc.**—To impress on management the effect of controllable losses for shrinkage, etc., separate costs for such losses may be computed. Thus in discussing costs in the manufacture of plate glass, Harold (N. A. C. A. Bulletin, vol. 21) states:

the cost sheet instead of showing the semifinished stocks transferred from one department to the next shows only the value of the shrinkage in each. The footage of shrinkage is obtained from the subsidiary record of flat glass stocks and for each department so affected is priced at the average price to date of the total glass received to date by each department. The item of shrinkage is a most important factor in our cost and one of particular interest when comparing similar operations at different locations.

Blocker (Cost Accounting) advocates segregation of such losses into those that are normal and those considered abnormal. The **abnormal shrinkage** or **spoilage** is to be closed out to Profit and Loss, while the **normal spoilage** is to be absorbed in the cost of the good units produced. He states:

The number of units lost, spoiled, and defective due to abnormal conditions should be multiplied by the cost per unit in the process and the resulting amount should be charged to a Lost, Spoiled, and Defective Work account and credited to the process through the medium of a journal entry. The special loss account should be closed directly to Profit and Loss so the inventories will not be improperly inflated.

The normal cost of spoiled and lost units is absorbed as an additional cost of units in process.

An example of separate costing of spoilage is shown below. It is adapted from Lange (Cost Accounting).

PROCESS B			
Inventory	\$ 1,230 00	Spoilage	?
Material	790 00	Transferred to Finished Goods	?
Labor	3,710 00	Inventory	?
Expense	1,484 00		
Transferred from A	13,680 00		

#### Production data

		Units
1 Opening Inventory		300
a Material	50% complete	
b Labor and Expense	80%	
2 Transferred from A		3,800
3 Delivered to next process		3,500

				Units
4	Spoilage			100
a	Material	100%	"	
b	Labor and Expense	50%	"	
5	Inventory at end			500
i	Material	100%	"	
b	Labor and Expense	80%	"	

## EFFECTIVE PRODUCTION

(Schedule 1)

	Physical Units	Effective Units	
		Material	Labor and Expense
1 Opening Inventory required to complete	300	150	60
2 Started and Finished	3 200	3 200	3 200
3 Spoilage	100	100	50
4 Inventory at end already completed	500	500	400
Total Physical Units	<u>4 100</u>		
Effective Production		<u>3 950</u>	<u>3 710</u>

## SPOILAGE AND INVENTORY VALUATIONS

(Schedule 2)

	Spoilage		Inventory	
	Completion	Value	Completion	Value
1 Unit Cost				
Transferred Cost	100%	\$3 00	100%	\$3 60
Material	100	20	100	20
Labor	50	50	80	80
Expense	50	20	80	32
Cumulative Unit Cost		<u>\$4 50</u>		<u>\$4 92</u>
2 Number of Units		100		500
3 Total Value		<u>\$ 450</u>		<u>\$2 460</u>

## COST OF PRODUCTION ANALYSIS

	Effective Quantity (Schedule 1)	Physical Quantity	Total Cost	Cost Unit
1 Opening Inventory		300	\$ 1 930 00	\$4 10
2 Received from Process A		3 800	13 895 00	3 60
3 Current Costs				
Material	3 050		795 00	20
Labor	3 710		3 710 00	1 00
Manufacturing Expense	3 710		1 434 00	40
Total Conversion Cost	3 710		5 194 00	1 40
4 Total Process Charges		4 100	20 894 00	
5 Less Spoilage (Schedule 2)		100	450 00	4 50
Inventory at end (Schedule 2)		500	2 460 00	4 92
Total Deductions		600	2 910 00	
6 Cost of Transfer to Finished Goods		3 500	\$17 984 00	



## PROOF OF TRANSFER TO FINISHED GOODS

	% Re- quired to Complete	Physical Quantity	Total Cost	Unit Cost
1 Opening Inventory				
Prior Cost		800	\$ 1 930 00	\$4 1000
Material Current Period	50%		80 00	1000
Conversion Cost (Labor and Expense)	20%		94 00	2900
Inventory Value Transferred		800	1 344 00	4 4900
2 Started and Finished in Current Period				
Prior Cost		3 700	11 720 00	3 0000
Material			640 00	2000
Conversion Cost (Labor and Expense)			4 480 00	1 4000
Value of New Production		3 700	16 640 00	5 2000
3 Total Value of Transfer		3 500	\$17 094 00	\$5 1883

**EFFECT OF SPOILAGE ON UNIT COSTS**—Blocker (Cost Accounting) shows effect of shrinkage and similar losses on unit costs. He states:

As a normal condition if units are lost or spoiled in a beginning process the production in terms of completed units is divided into the total cost of the process the loss being absorbed by units finished and in process. The same procedure is followed in subsequent processes but in addition the accumulated value of units transferred and lost in a process must be absorbed by units finished and unfinished in the process responsible for the loss.

An illustration of the above is given in Fig. 16 taken from the same source. The unit conversion cost in process 2 is found by dividing \$6 300 by the effective production (9 000 units). The following method shows the increased cost due to shrinkage:

Cost in Process 1 before shrinkage (20 000 - 10 000)	\$2 00000
Cost in Process 1 after shrinkage (20 000 - 9 500)	2 10526
Increased Unit Cost due to shrinkage	<u>\$ 10526</u>

	Process 1	Process 2	Total Costs
Material	\$10 000		\$10 000
Labor	6 000	\$ 4 500	10 500
Factory expense	4 000	1 800	5 800
Total process costs	<u>\$20 000</u>	<u>\$ 6 300</u>	<u>\$26 300</u>
Cost transferred		\$20 000	
Accumulated costs		<u>\$26 300</u>	
Units received	12 000	10 000	
Units spoiled	2 000		
Units lost (shrinkage)		500	
Units in process ( $\frac{1}{2}$ completed)		1 000	
Units transferred	10 000	8 500	
Unit cost in each process	\$ 2 00	\$ 70	
Loss per unit due to shrinkage		10526	
Accumulated unit cost	2 00	2 80526	

Fig. 16 Effect of Shrinkage and Spoilage on Unit Process Costs

**RECLAIMED MATERIALS**—Reclaimed materials are usable stores items which have been salvaged from spoiled work. Where it is desired to record spoilage costs separately in the accounts this may be accomplished through the use of spoilage reports showing spoilage cost, reclaimed material, etc., which form the basis for a monthly journal entry.

Manufacturing Expense Control

\$

Stores

Process A, etc.

\$

The debit to Manufacturing Expense is supported by detailed postings to the departmental standing orders. The debit to Stores account is supported by stores ledger for

- 1 Reclaimed material item
- 2 Scrap account

## Process Cost Statements

**COMPARATIVE UNIT PROCESS COSTS**—In industries where operations are repetitive and continuous unit costs ought to exhibit a high degree of stability. Variations in costs are an indication of the presence of factors out of the ordinary. This is illustrated by Mengel in discussing anthracite mining costs (N. A. C. A. Bulletin vol. 22).

The sources that produce a red figure in any month are the ones that come in for special attention and study by the local management.

In other words cost variations are looked for and the reasons for the variations are investigated. In this connection process cost accounting permits easy computation of costs as often as desired. The frequency of computation depends on the type of industry, particularly on the rapidity of inventory turnover, or on the length of manufacturing cycle.

Where there are no process variations or where a manufacturing cycle is completed in 24 hours, daily reports are the rule. This is the case in bike shops, dairies, etc. John F. Ulrich, discussing bike shop costs (N. A. C. A. Bulletin vol. 16) speaks of daily reports in the form of a daily recapitulation summary which accounts for quantities and values of different balance products on all routes (Fig. 17).

In addition, the production figures on the daily statement furnish a basis for the monthly production summary assuming the tie-in of daily and monthly figures as to quantities and values.

Coal mines furnish an example of high turnover since they load and dispose of coal about as fast as it is mined. Mengel speaks of daily costs for anthracite coal mines (N. A. C. A. Bulletin vol. 22).

A daily cost sheet is made up for current guidance. This is available on the morning of the day following, the working day and is quite accurate except for piecework earnings, which must be approximated as certain information on this is available only at the end of the semi-monthly survey. Idle day costs are kept separately from working day cost so that proper comparisons may be made with standards; this is especially necessary in coal mining, where the working days, month by month fluctuate from as low as 8 in the summer to as high as 22 in the winter.

DAILY RECAPITULATION SUMMARY				Day, _____ 19__			
SCALING							
PRICE							
BREAD-ROLLS	CASH VALUE						
Inventory							
Production A M							
Production P M							
Returned							
Purchased							
Returns							
TOTAL TO ACCOUNT FOR							
Balance							
TOTAL ROUTES							
Special Delivery							
W. Mag. Sales XX							
Home Sales XX							
Salesmen XX							
Shipping							
Shipping Extra							
TOTAL SALES							
Ready Deposits							
Returned							
Inventory Today							
TOTAL RE- COUNTED FOR							
Sales							
Over							
Cracks							

FIG 17 Daily Production and Sales Report of Quantity and Value

The same condition obtains for open cut mines described by Avery (N & C A Bulletin, vol 22) Daily statements are prepared as follows

- 1 Superintendent's Daily Cost Statement (Fig 18)
- 2 Summary of Payroll
- 3 Supplies Expense Sheet

All of these are summarized on semi-monthly statements

In the manufacture of hatter's fur, department foremen prepare daily production data These are posted daily to a summary analysis sheet

to furnish data for monthly closing journal entries (Fig 13) Important advantages in daily cost computations are

- 1 Ability to take prompt action in case of unfavorable costs before too much damage is done
- 2 Shortcoming of time for preparation of monthly reports

The latter situation is emphasized by Adamson explaining costs in sulphur mining (NACA Bulletin vol 15) Punched card equipment is used and the information is recorded daily

By constant effort we manage to get practically all invoices into the Freeport office by the first or second day of the succeeding month at the

# CLEARDALE COAL CORPORATION Superintendent's Daily Cost Statement

Penna Mine

## LABOR

Men hrs	Account	Cost Today	Cost To Date Yr
No 011 Coal Shovel			
2 19	a Engineer	\$24 35	\$597 56
2 6	b Oilier	12 05	298 76
2 15	c Pit Men	15 19	369 75
	d Dril & Sht E		
	e Cleaners Machines		
3 12	f Coal	10 33	433 37
3 6	g Tractors	6 34	122 75
2 6	h Rep & Coal Shovel	6 09	199 09
2 14	j Repairs Tractors	12 14	316 76
16 70	Total Co-t	91 49	\$418 25
	Per Ton	033	037

No 001 Haulage

Total Labor Co t	1162 69
Per Ton	421

Total Labor Co t	1162 69
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Total Labor Co t	1162 69
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Total Labor Co t	1162 69
Per Ton	421

Fig 18 Daily Cost Statement

latest. This tardiness can be allowed only to those few important ones that are absolutely unobtainable sooner. Our material distribution is closed on the evening of the last day of the current month. The final invoices that are cleared through the warehouses must reach the Freeport office not later than that hour. By that time the majority of the invoices have been received already as they are sent in regularly throughout the month.

**MONTHLY PROFIT AND LOSS STATEMENTS**—In general, the monthly operating statements depend on the nature of the industry, size of plant, and the degree to which management is aware of a need for cost reports and statistics in controlling operations. In process cost plants departmental production cost analysis is usually the first and most basic report prepared. It is a direct outgrowth of the departmental unit cost computations, valuation of transfers inventories in process, spoilage, etc. The statements themselves may be very simple or become very complex depending on

- 1 Number of products manufactured
- 2 Extent of subclassifications desired
  - a By products
  - b By elements of cost
  - c By departments or processes
  - d Or by any combination of the above

**Analyses and Comparisons**—The following reports are listed as desirable for a large bakery by Henry (N. A. C. A. Bulletin, vol. 20)

- 1 Daily weekly and periodical record of production and the disposition of the same together with significant cost factors
- 2 Weekly and periodical analysis of production by varieties showing the quantities, weights, and values of the different varieties produced
- 3 Weekly analysis of sales by routes, divisions and various other sales classifications
- 4 Weekly reconciliation of stocks showing the source and disposition of the same

**Periodic statements** are also prepared. These consist of the usual balance sheet and profit and loss statement. The latter is supported by the following schedules or analyses

- 1 Analysis of profit or loss by sales classification
- 2 Material cost analysis and production cost factors including average yield of baked out production per barrel of flour and average cost of flour per barrel
- 3 Detail of manufacturing general plant and plant office expense
- 4 Detail of selling and delivery expense and analysis of portions applicable to various sales classifications
- 5 Detail of nonoperating income and expense
- 6 Analysis of controllable labor costs such as direct shop labor, wrapping labor and shipping clerk's wages
- 7 Periodic transportation report showing for each vehicle the mile age, gas, oil, etc.
- 8 Analysis of poundage, average price and value of various kinds of wrappers used

An important feature of process cost statements is the ease with which comparative cost reports may be prepared. In the case of bakeries, periodic analyses of the Profit and Loss statements are prepared. The

total and average per hundredweight figures for all plants are calculated and compared with the per hundredweight figures of the best plant and with those of each plant. This is a favorite method of statistical presentation by trade associations but applies equally well to manufacturers operating several plants making the same product.

The columns of each sheet of these statements are headed as follows

Best Plant

Your Plant { Previous Period  
Current Period

Average Figures

Excess Over Average

A different type of analysis and comparison is presented by Adamson (NACA Bulletin vol 15) in connection with sulphur mining. He shows the necessity for a monthly production cost statement showing the following information

- 1 Variable Costs
  - a Plant Production Expense—
    - i Fuel Sulphur Wells
    - Other Costs
  - b Field Production Expense
  - c Miscellaneous Production Expense
- 2 Fixed Costs
  - a Royalty
  - b Production Taxes
  - c Property Taxes
  - d Depreciation
- 3 Administrative Expense
- 4 Total Production Cost

There are five columns of figures to the right of the above items showing

Monthly Cost a Year Ago	Current Months Budget	Current Months Cost	Cost per Ton	Total Cost for Period
-------------------------------	-----------------------------	---------------------------	-----------------	--------------------------

The following are also included on the summary page

- 1 Average production cost for each mine
- 2 Shipping and cart loading cost
- 3 Prospecting and development
- 4 Capital expenditures
- 5 Minor subsidiary companies

Supporting schedules detailed by each work order number divided as to Labor Material Expense Total and Budget complete the statement

**STATEMENTS FOR MULTI PROCESS PLANTS**—If there are no process inventories the cost of production analysis may be obtained directly from the process cost sheet. The elements of cost are shown at the left of the sheet while across the page are shown processes each being subdivided to show

- 1 Quantity
- 2 Total Cost
- 3 Unit Cost

Costs need not be transferred from column to column but may be accumulated in a total cost column. Fig 19 used by Blocher (Cost Accounting), illustrates this point. In the same way production cost

PRODUCTION EXPENSES	SEWING ROOM		BLOWING		TUFTING AND FINISHING		INSPECTION AND WRAPPING		TOTAL COST	
	Cost	Cost per Unit	Cost	Cost per Unit	Cost	Cost per Unit	Cost	Cost per Unit	Cost	Cost per Unit
<b>MATERIALS</b>										
Ticking										
Cotton										
Thread										
Twine										
Miscellaneous Supplies										
Mattress Bags										
Total Material Cost	\$ 785	\$ 785	\$4 010	\$4 01	\$ 95	\$ 095	\$ 80	\$ 08	\$4 970	\$4 97
<b>LABOR</b>										
Direct Labor Payroll										
Clerical Payroll										
Supervision and Executive Payroll										
Total Payroll Cost	\$ 650	\$ 65	\$ 320	\$ 32	\$1 210	\$1 21	\$200	\$ 25	\$2 430	\$2 43
<b>FACTORY OVERHEAD EXPENSE</b>										
Rent										
Depreciation of Equipment										
Storage										
Power and Light										
Telephone and Telegraph										
Insurance										
Taxes										
Repairs										
Miscellaneous Factory Expenses										
Total Factory Expenses	\$ 138	\$ 138	\$ 188	\$ 188	\$ 130	\$ 13	\$ 49	\$ 049	\$ 505	\$ 505
Total Costs	\$1 573	\$1 573	\$4 518	\$4 518	\$1 435	\$1 435	\$379	\$ 379	\$7 905	\$7 905

Number of mattresses completed during January—1 000

FIG 19 Process Cost Statement in Analytical Form (by elements and processes)

analysis according to products may be shown. Fig. 21 shows such a report for a cannery.

The same information may be presented in report form particularly where costs are transferred from process to process. Fig. 20 from Amudon and Lang (Essentials of Cost Accounting) shows such a statement applicable to brick making.

STATEMENT SHOWING BRICKS PROCESSED TOGETHER WITH  
TOTAL AND UNIT COSTS BY DEPARTMENTS

FOR THE FISCAL YEAR ENDED OCTOBER 31 19—

	Quantity Processed (in thousands)	Total Cost	Unit Cost
Quarrying Cost		\$	\$
Placed in Pans and Machines		\$	\$
Spoiled in Pans and Machines			
Produced			
Cost of Production Pans and Machines			
Cost of Bricks Put in Dryers			
Inventory of Bricks Half Dried at beginning			
Drying Cost			
Total			
Cost of Bricks in Dryers at end			
Bricks Dried			
Bricks Spoiled in Drying			
Cost of Good Bricks Dried			
Setting Cost			
Cost of Bricks Set in Kiln			
Inventory in Kilns at beginning			
Burnt			
Burning			
Green			
Burning Cost for Year			
Total			
Bricks Spoiled in Burning and Sold			
Cost of Good Bricks Processed			
Inventory in Kilns at end			
Green			
Burning			
Burnt			
Cost of Bricks Unloaded			
Unloading Cost			
Works Overhead			
Cost of Burnt Bricks in Yard			
Inventory of Burnt Bricks at beginning			
Total Bricks Available for Sale			
Inventory at end			
Cost of Sales		\$	\$

FIG 20 Process Cost Analysis in Report Form



SYRUP DEPARTMENT COSTS													
Material Costs	ACTUAL GALS PRODUCED	MATERIALS								PER GAL PRODUCED			
		SUGAR		CHEM		EXTRACT		WATER		TOTAL		Act	Std
		Act	Std	Act	Std	Act	Std	Act	Std	Act	Std		
<u>Flavors</u>													
Orange Ade													
Lemon and Lime													
Root Beer													
Etc													
<u>Total Materials for Syrup</u>													
<u>Variable Syrup Expense</u>		Act	Std	<u>Fixed Syrup Expense</u>									
Labor				Depreciation - Buildings									
Repairs				- Machinery									
Power				Labor									
Steam				- Superintendent									
Spoilage - Net				- Night Watchman									
Miscellaneous				Insurance									
				- Compensation									
				- Bldgs & Mach									
<u>Total Variable Syrup Expense</u>				Taxes									
<u>Per Gallon produced (All flavors)</u>				<u>Total Fixed Syrup Expense</u>									

FIG 21 Separate Departmental Cost Statement

In large plants it is preferable to prepare **separate** statements for each department, copies of which may then be furnished to department heads concerned. These statements are later summarized in a single statement covering the entire plant. Fig. 21 by Jones (N. A. C. Bulletin, vol. 16) shows a statement covering the syrup department in a plant making ginger ale and other carbonated drinks.

## DETAILED ANALYSIS OF WORK IN PROCESS INVENTORY

JANUARY 31, 19—

To	Direct Material	Direct Labor	Overhead Expense	Department			Total		
				\$1	\$2	\$3	I	Q	R
\$173.00	\$ 800.00 00.00 431.00			\$ 800.00	\$ 500.00	\$ 43.00	\$ 80.00 50.00 43.00		
	\$ 738.00							\$ 500.00 3.00 00.00	
	\$ 500.00 300.00 00.00			500.00	300.00	10.00			
11.00	\$ 1.00								
	\$ 4.00 75.00 39.00			401.00	75.00	75.00			\$ 4.00 75.00 39.00
15.00	\$ 515.00								
\$5.30				\$ 7.00	\$ 875.00	\$ 6.00	\$173.00	\$ 80.00	\$ 5.00
				\$ 41.00	\$ 97.00	\$ 45.00	\$ 40.00 45.00		
\$ 94.00	\$ 94.00			5.00	158.00	1.00	\$ 7.00 1.00		
6.00	\$ 1.00 58.00 1.50								
	\$ 60.00			60.00	335.00				\$ 60.00 335.00
00	\$ 5.00								
\$ 4.00				\$ 80.00	\$ 00.00	\$ 44.00	\$ 80.00	\$ 00.00	\$ 5.00
			\$ 55.50 445.50 45.00	\$ 55.50	\$ 445.50	\$ 45.00	\$ 55.50 445.50 45.00		
\$ 42.00			\$ 63.00						
			\$ 345.50 37.00 195.00	345.00	37.00	195.00		100.00 1.00 1.00	
777.00			\$ 00.00						
			\$ 2.00 5.50	2.00	5.50				
00			\$ 7.00						
1				\$ 00.00	\$ 185.00	\$ 44.00	11.00	00.00	
\$5.00	\$1.00.00	\$ 114.00	\$273.00	\$ 1.00	\$ 8.00	\$1.00	\$ 00.00	\$ 1.00	\$ 1.00

FIG. 22 Detailed Multiple Analysis to Support Cost of Production Report

In Fig. 2 costs were analyzed by elements, departments, and products. To obtain this statement detailed analysis is required for each item. Fig. 22 used by Van Sickle (*Cost Accounting*) shows the extent of such detail in supporting the earlier illustration. Such underlying detail should not be incorporated in the report to management. It should remain part of the cost department's working papers, available when called for. Its introduction as part of the cost report confuses more than it helps.

## Class or Product Costs

**DEFINITION OF CLASS COSTS**—In many lines of manufacture a variety of similar products is produced by means of the same group of processes. Where this condition exists separate cost accumulations may be made for each product or each group of products rather than for individual items. This is known as class or product costing. Class costs have been defined by Dohr, Ingham and Love (*Cost Accounting*) as

A method of accumulating costs relating to classes of product in which the total cost of any class is divided by the number of units in the class, to determine the unit cost. A class is usually a group of similar jobs or units of product.

There is some doubt whether class costs represent some variation of job order or process costing. In the latter costs may be formed by processes, product elements, etc. If costing on a product basis is selected, costs are apportioned to each product on one of two bases:

- 1 Formula basis such as weight, etc.
- 2 By introduction of job order technique in order to assure specific allotment of costs to each product.

On the basis of the first method, process costing is involved. On the basis of the second, job order costing is indicated.

**PRODUCT CLASSIFICATION**—The object of cost accumulation by product classes is to simplify the cost procedure by grouping the products into a relatively small number of classes and thus effecting clerical savings.

A common illustration of class costs is a foundry where castings are grouped and costed by weight classifications. While objection has been raised to this method of cost accounting, on many occasions, nevertheless it suffices under certain conditions. The principle of class costs is applicable to many conditions and companies.

Dohr, Ingham and Love (*Cost Accounting*) state

In establishing the product classification the product as a whole is analyzed and a grouping made on the basis of such similarity as may exist in the manufacturing and distributing conditions. The groups may include all products of a given style, shape or use; all products requiring the same raw materials; all products going through the same processes in the factory; or all products sold through a given sales channel. In establishing the classification consideration must be given to the fact that the operation of the system requires that material costs, labor costs, factory service and distribution costs be allocated to the various groups of the classifica-

tion and if possible the classification should be made to facilitate such allocation

With product classes established the system usually provides for each class of product

- 1 Analysis of sales and sales returns
- 2 An analysis of purchases and purchases returns
- 3 An analysis of inventories
- 4 An analysis of manufacturing costs
- 5 An analysis of distribution costs
- 6 An analysis of administrative costs

All of this is similar to process cost procedure where costs may be gathered according to individual products instead of groups of products

**Basis of Classification**—Newlove and Garner (Elementary Cost Accounting) give an example of product classification for a foundry as follows

#### CLASSIFICATION OF CASTINGS BY CLASS

Shape	Codes		
	1 0	No Core	0
Simple	2 0	Plain Core	3
Complex		Complex Core	4

#### WEIGHT OF CASTINGS

Pounds	Code
1 to 10	10
11 to 25	20
26 to 50	30
51 to 100	40
101 to 200	50
201 to 300	60
301 to 400	70
401 to 500	80

The use of the class code is explained by the following examples

Class Code	Weight of Casting Pounds	Shape of Casting	Type of Core
11 0	1 to 10	Simple	No Core
22 0	11 to 25	Complex	No Core
22 3	11 to 25	Complex	Plain
41 4	51 to 100	Simple	Complex
42 4	51 to 100	Complex	Complex

From the same source comes a chart (Fig. 23) showing underlying details for Work in Process Control in class cost procedure. The illustration is for the molding department of a foundry in which castings numbered 120 to 125 are Class A and 126 to 130 are Class B.

In this illustration figures in the small rectangles in the factory order column represent the number of units to be produced. The total for Class A is 19, for Class B 18. It is however not necessary to set up job cost sheets as shown in the last column, since the whole object of class costing is to eliminate precisely the detailed clerical work connected with job order costing. This point is emphasized by Bennett discussing costs in a factory making maple furniture (N A C A Bulletin, vol 19)

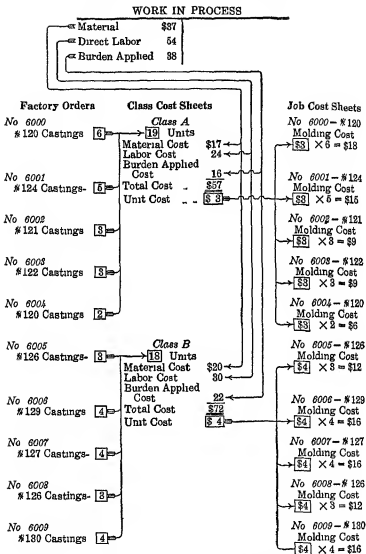


FIG. 23 Work in Process Control and Subsidiary Class Cost Records

He advocates a system of standard costs for each product and all cost collecting by jobs discontinued

**Number of Product Classes**—The number of product classes should be held to a minimum. In connection with foundry castings illustrated above, there is a maximum of 48 classes provided in each cost period. Newlove and Garner (*Elementary Cost Accounting*) state

While this would be a rather large number the costing would still be simpler than if cost sheets were prepared for each individual casting. The latter procedure might involve the preparation of several thousand cost sheets during the course of a fiscal period.

Dohr, Ingham, and Love (*Cost Accounting*) state that product classification requires analysis of the product into comparatively few classes or divisions. They point out further that the system does not permit determination of costs by units of product unless classes of product are few and of uniform nature.

**CLASS COST PROCEDURE**—A common method for cost accumulation is to issue a production order for a number of items which go through similar manufacturing operations but which vary in some slight particular. The primary accumulation is made by processes and average unit costs determined in the same way as in ordinary process costing.

Since different products may be manufactured from different raw materials **direct material cost** is assigned to a product class rather than to a department or process. The total of labor and factory overhead of each department or process, sometimes called **conversion cost**, is then divided by the units of all types of products passing through that operation to get an average unit operation cost. The completed cost of a unit of any product is then determined by adding to the raw material cost the unit cost of each operation or process involved in the manufacture of that product.

## Operation Costs

**DEFINITION**—Operation costing represents a refinement of process cost procedure. It implies cost determination by operations instead of processes. In the production of like articles or finished materials where units cannot readily be distinguished one from another, a cost accounting system to record costs of product by operations may be desirable. There are a number of products of standard caliber which are susceptible to this method of cost treatment such as cement, refined sugar, pig iron, steel, manufactured gas, rubber products and others.

Newlove and Garner (*Elementary Cost Accounting*) state

Under this system the fabricating processes are divided into standard operations, and the cost of each operation is computed.

According to Dohr, Ingham and Love (*Cost Accounting*), operation costs are explained as follows:

A process is sometimes subdivided into parts to which the term operation is applied. Thus a given process may include several operations.

Along the same line, Blocker (Cost Accounting) states

The accounting procedure is identical with the one followed in process cost accounting, except the costing division is an operation rather than the larger sphere of activity designated as a process.

**OPERATION AND PRODUCT COSTS COMPARED**—Differences between these two variants of process costing are explained by Newlove and Garner (Elementary Cost Accounting)

When the costs need be analyzed only down to the different operations the term operation cost method is often employed. If cost must be analyzed through the operations to the various products, the term product costs may be used. It should be recognized that these two methods are in reality just variations in process cost accounting procedure which for the sake of clearness are given separate names. There are, in fact, four possible divisions into which process costs can be analyzed:

- Case A When the factory has one operation and one product
- Case B When the factory has one operation and more than one product
- Case C When the factory has more than one operation and one product
- Case D When the factory has more than one operation and more than one product

Following the above definitions Case A and Case C call for the operation cost method while Case B and Case D require the product cost method. Of course it is immaterial whether Case A is regarded as operation or product costing, but since the classification goes only up to the operation stage it is a little clearer to consider it as an illustration of operation costs.

**AVERAGE UNIT OPERATION COSTS**—The cost procedure is exactly the same as for process costing. Like the latter, operation costs represent average costs as indicated in the following illustration:

Upon completion of a motion picture master print 100 positive prints may be required. It is possible to accumulate costs incurred for the production of the 100 positive prints, divide the total cost by 100 and obtain the cost of each print. For control purposes a cost figure of this kind is not desirable as many separate and distinct operations are involved which incur material and labor charges. If material labor and burden charges are segregated by operations the excess cost factors are discovered and costs reduced. The necessity for operation costs is purely a managerial requisite. The total cost of one positive print of 5000 ft. might be \$100. A much better realization of cost may be had if this cost were analyzed as follows:

	Material	Labor	Burden	Total	Unit Costs
Printing	\$120	\$ 5	\$ 5	\$130	\$1.30
Developing	10	10	10	30	30
Drying	-	5	5	10	10
Trimming	-	5	5	10	10
Inspection	-	5	5	10	10
Totals	<u>\$130</u>	<u>\$30</u>	<u>\$30</u>	<u>\$190</u>	<u>\$1.90</u>

**ELEMENTS OF COST**—Operation cost determination requires the proper recording of cost elements (material, labor, expense) and a decision as to the transfer of costs from operation to operation.

Material may be charged to operations along with labor and manufacturing expense or material may be separately set up and only conversion cost, that is labor and expense charged to each operation. An example of the latter method is given by Doll (Fig 24) for a paint manufacturer (N A C A Bulletin, vol 19)

## BULK COSTS

Materials	Lbs	Bulking Value (in gal.)	Dehydrated Price	Shrink Cost	Amount
Lead Carbonate	350	6 17	\$ 075 per lb	\$ 0754	\$ 26 30
Lithoponc	400	11 17	06 per lb	0003	24 12
Titanium Pigment	120	3 65	20 per lb	201	24 12
Inert Pigment	80	3 37	02 per lb	0201	1 01
Linseed Oil	170	22 00	80 per gal	808	17 78
Drier	7	1 00	60 per gal	618	62
Total Paste Paint	1 127	47 36			\$ 94 04
Linseed Oil	256	33 00	80 per gal	808	26 00
Drier	28	4 00	00 per gal	618	2 47
Thinner	40	6 50	10 per gal	102	06
	1 451	90 86			
Mfg Shrinkage 2%	29	1 82			
Total Finished Paint	1 422	89 04			\$124 43
Material Cost per 100 gallons (\$124 43 - 8004)					\$130 77
Operations					
Handling (\$ 10 per cwt)				\$1 50	
Mixing (\$2 per 100 gal)				2 00	
Grinding (4 hrs @ \$ 75)				3 00	
Thinning (\$ 25 per 100 gal)					
Tinting (\$1 50 per 100 gal)				2 00	
Testing (\$ 25 per 100 gal)					
Manufacturing Cost					\$ 59
Total Bulk Cost					\$148 36

FIG 24 Operation Cost Assembly

The shrink cost in the illustration is found by increasing the dehydrated price as follows

Dry pigments	1 50
Oils	1
Thinner	2
Driers	3

The manufacturing shrinkage is absorbed in net production thus increasing the cost per 100 pounds

**COST TRANSFER**—According to Newlove and Garner (Elementary Cost Accounting) two methods of transferring costs are possible. Under the first method costs are transferred from operation to operation and are thus cumulative. Under the second method, costs connected with each operation are kept distinct from costs of other operations. Total product costs are found by adding the costs for each operation. Where a partially processed product is sometimes sold, the first method







card for comparison. Material and labor data are collected on subsidiary forms and entered in summary on this cost sheet.

An example of cumulative costing by transferring costs from operation to operation is given in Fig. 26 and explained by Hollowbush (NACA Bulletin vol. 16). The exhibit shows the cost report of a crude rubber department divided into the following operations:

- 1 Cutting
- 2 Washing and drying
- 3 Refining

Note that unit costs in column 1b are transferred to column 7 of the next operation. New code numbers are assigned to the rubber (column 1b) which indicate the stage of processing reached. Since not all rubber goes through the same processes the use of such codes makes it easier to follow the operations and transfers on the cost report.

**OPERATION COST SHEET**—Process costs by operations have certain fundamental characteristics that may be set forth as a basis of cost finding. In each operation items of raw materials, direct labor, and burden are involved. As the operation method of cost accounting is applied for the most part to factories working on a continuous production basis, opening and closing inventories are likely to be found. Fig. 27 presents a form of cost sheet of considerable value in the determination of production costs by the operation method. Nine specific opera-

	Operation 1 \$ or lbs	Operation 2 \$ or per	3	4	Salvage Adjustment	Control Figures
<b>FACTORY COST</b>						
In process beginning of period						
Received during period						
This period's material						
This period's labor						
This period's expense						
Total						
Discarded during period						
Worked and delivered						
In process end of period						
<b>QUANTITY PRODUCED</b>						
In process beginning of period						
Received during period						
Total						
Discarded during period						
Worked and delivered						
In process end of period						
<b>COST PER UNIT</b>						
Cumulative cost carried forward from preceding operation						
Material, labor and expense						
Discard loss						
Total						
<b>ANALYSIS OF TOTAL UNIT COST</b>						
Material, labor and expense						
Discard loss						
Total						

FIG. 27. Cost Sheet for Operation Costs

OPERATION COST SHEET												STYLE NO _____	
DESCRIPTION		WEIGHT PER DOZEN		QUANTITY		COST PER DOZEN							
		Mo	Price	Amount	Mo	Price	Amount	Mo	Price	Amount	Mo	Price	Amount
<b>MATERIALS</b>													
	Raw Mat'l												
	Fabric												
	Thread												
	Buttons												
	Cambric												
	Labels												
<b>OPERATIONS</b>													
	Killing												
	Pressing												
	Cutting												
	Seaming												
	Finishing Seams												
	Hemming												
	Making												
	Putting on Buttons & Labels												
	Folding												
	Total Labor												
	Material Burden												
	SUMMARY												
	Material												
	Labor & Burden												
	Total Unit Cost												
	Total Cost												
	Selling Price												
	Date												

Fig 28 Operation Cost Sheet

tions are provided for and of course, provision may be made for a larger or smaller number of operations. The cost sheet is divided into three sections, namely **Factory Cost**, to deal with values **Quantity Produced** to deal with quantitative data and **Unit Cost** together with an analysis of the unit cost as between the cost of materials labor burden and discard loss or scrap. Comparison of the discard loss for each operation for various runs is thus available for foremen to control

This form of cost sheet is readily adaptable to operation cost problems and may be used for a single part subassemblies or final assemblies. The company using this form reports that actual cost finding was simplified to a considerable extent by its adoption. With the use of this form a record of materials labor and burden is secured operation by operation. Comparative costs of various parts produced are prepared from month to month giving the management a definite view of factory operations.

An example of an operation cost sheet suitable for use with a standard cost system is in Fig. 28. According to Bennett (N. A. C. A. Bulletin vol. 18) this cost sheet provides columns in which to refigure costs six times on each side of the sheet. It is useful in the early days of an installation if standard costs are set up on a more or less estimated basis, instead of a careful analytical study.

## SECTION 10

### JOINT AND BY PRODUCT COSTS

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## SECTION 10

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# JOINT AND BY-PRODUCT COSTS

### Definitions and Characteristics

**IMPORTANCE OF JOINT COSTS IN INDUSTRY**—Joint costs occur under two different conditions

- 1 Joint overhead costs representing the cost of services which are to be apportioned to various departmental accounts
- 2 Joint production costs where the processing of the raw material produces a variety of products

It is the second of the above conditions which forms the scope of this section. The first is discussed in Section 18.

One of the problems of the production engineer is the complete utilization of the raw material. An inevitable accompaniment of the production process is the appearance of waste and scrap. The trend of modern production is all in the direction of the elimination of such waste and to obtain a 100% yield from the raw material. Such yield may not be all in the form of one product but the effort of management is directed toward obtaining 100% utility, if necessary through a variety of products each of which represents an economic and commercially useful item. For instance in recent years, the wood distillation process first introduced by the Ford Motor Company, uses sawdust and waste wood and produces valuable by-products, such as charcoal, hardwood pitch, wood creosote, oil, calcium acetate, ethyl acetate, wood alcohol, etc. As competition brings about narrowing margins of profit, utmost utilization of raw material is imperative through the elimination of waste and its conversion into a by-product.

The importance of by-products and joint products is not always evident, particularly where the waste products have little value and profit margins on the major product are satisfactory. The continued drive for greater utilization in the production process has narrowed profit margins and has emphasized the importance of adequate accounting for joint costs. According to Greer (NACA Bulletin vol 17) among the industries which have found it necessary to give particular attention to this type of costing are the following:

- 1 Extractive industries (metal and coal mining, petroleum oil extraction and refining, logging and lumbering, etc.)
- 2 Agricultural product industries (meat packing, dairying, canning, milling, sugar refining, cotton ginning, cottonseed crushing, etc.)
- 3 Chemical process industries (manufacture of dyes, solvents, preservatives, fertilizers, explosives, etc.)



The essence of the problem consists in assigning costs to the individual products produced. This is done in a variety of ways discussed later in this section. In some methods the costs are prorated in others market values are assigned to individual products and in still others no attempt at all is made except to recognize the existence of a joint cost for all products manufactured. The problem has been recognized by economists as well as accountants. It is generally admitted that there is no ideal solution to the problem of joint cost distribution. In fact the economists are in general agreement on the proposition that the sales recovery from all the joint products is a function of the joint cost and that the assumed cost of any one product may not have any pronounced relationship to the selling price of that particular product.

**TYPES OF MANUFACTURING OPERATIONS**—Three types of manufacturing operations are in general use, according to Dohr, Ingham, and Love (Cost Accounting)

- 1 Ordinary manufacturing operations in which material labor and factory overhead may be computed for each job product or process
- 2 By product manufacturing operations in which production of a principal or major product is accompanied by production of one or more lesser or minor products
- 3 Joint manufacturing operations in which the costs are applicable to several products none of which is of sufficient importance to be considered as a major product

Bliss (Management Through Accounts) shows different cost formulas (Fig. 1) applicable to each case. These are illustrative only, other formulas are possible.

### DEFINITIONS—

**Waste**—that portion of a basic raw material lost in processing, having no recovery value.

**Spoilage**—defective portion of regular production having a value recoverable only through reprocessing.

**Scrap**—the incidental residue from certain types of manufacture usually of small amount and low value recoverable without further processing.

**By products** are products recovered from material discarded in a main process or from the production of some major product where the material value is to be considered at the time of severance from the main product. White (Journal of Accountancy, vol. 51) defines the term as "any salable or usable value incidentally produced in addition to the main product."

The research department of the National Association of Cost Accountants defines by-product (NACA Bulletin, vol. 1) as "an article of value incidental to the manufacture of the main product of an establishment or made from waste material arising from such manufacture." Similarly Bienvenu (Accounting and Business Dictionary) defines by-product as "the residue of material which has been used to produce a main commodity."

The above definitions emphasize by-products in terms of recoverable values from waste material resulting from manufacturing operations. They represent residuals of value, frequently requiring further process.

ORDINARY MANUFACTURING COSTS			MAJOR AND BY PRODUCT COSTS			JOINT COSTS		
1	Material cost	\$	1	Material cost	\$	1	Realizable value of all products	\$
2	Add labor cost	\$	2	Add labor and factory expense	\$	2	Deduct cost of materials	\$
3	Prime cost	\$	3	Total outlay	\$	3	Costs material	\$
4	Add factory expenses	\$	4	Deduct realizable value of by products	\$	4	Deduct labor factory costs selling and general expense	\$
5	Factory cost	\$	5	Balance factory costs of major product	\$	5	Operating profit	\$
6	Add selling and general expense	\$	6	Add selling and general expenses	\$	6	Deduct interest and federal taxes	\$
7	Sold cost	\$	7	Sold cost of major product	\$	7	Break-even results	\$
8	Add interest and federal taxes	\$	8	Add interest and federal taxes	\$	8	Deduct dividend requirements	\$
9	Break-even cost (to stockholders)	\$	9	Break-even cost (to stockholders)	\$	9	Margin for addition to surplus	\$
10	Add dividend requirements	\$	10	Add dividend requirements	\$			
11	Total cost including interest and dividend requirements	\$	11	Total cost including interest and dividend requirements	\$			
12	Actual selling price—net	\$	12	Actual selling price of major product—net	\$			
13	Margin for addition to surplus	\$	13	Margin for addition to surplus	\$			

FIG 1 Cost Formulas for the Three Basic Types of Industrial Operations

ing incidentally recovered from operations performed in the manufacturing of a main product whose market exploitation is the major cause of sales effort.

Thus Clemen (By Products in the Packing Industry) states "A packer considers as by product everything of value produced on the killing floor other than dressed meat."

**Illustrations of By Products**—The following are typical examples of by products:

- 1 Cottonseed accompanying cotton. The seed was formerly thrown away or used only as fertilizer. It is now the basis of a great oil and oil cake industry.
- 2 The bagasse from the grinding of sugar cane, formerly a waste product, is now used to make wallboard.
- 3 The molasses left as a residuum in the making of sugar formerly wasted for the most part is now the raw material for industrial alcohol.
- 4 Methanol is now made from several former waste products, i.e. from
  - a Gas from the manufacture of butyl alcohol and acetone
  - b Gas from calcium carbide furnaces and
  - c Gas produced in the fixation of nitrogen
- 5 Linoleum is made in part from waste from the manufacture of cork products.
- 6 Paper is made in some places from what formerly was sawmill waste.
- 7 Fish offal is made into oil and fertilizer.
- 8 Small waste timber is made into rayon.
- 9 In the manufacture of coke there are found such residuals as sulphate of ammonia, coal tar, benzol and gas plus many others, all of which can be considered as by products.
- 10 In the flour milling industry the production of high grade flour is accompanied by the production of low grade flour, mill feed bran, etc.
- 11 In the dairy industry the production of butter and cheese is accompanied by the production of buttermilk.
- 12 In the manufacture of soap in the process of mixing and boiling ingredients sundry rejections take place, some of which are collected for recovery as by products, such as glycerine.
- 13 The top layer on the surface of the molten metal in a blast furnace is a by product known as slag which is successfully used in the manufacture of Portland cement.
- 14 Packinghouse by products are of two kinds, edible and inedible. The edible products prepared from hearts, livers, brains, ox tails, kidneys, sweetbreads, tongues, etc. are obtained in the slaughter of livestock. The inedible products are subdivided into a number of representative classes. Hides, skins and pelts are processed into leather; wool, curled hair and other products; fats into tallow and greases; glands into pharmaceutical products; bones, blood and scraps into animal feed; fertilizer material, and various other products.

**Grouping and Sources of By Products**—By-products can be classified into two groups according to their marketable condition at the time they come into existence, namely:

- 1 Those that can be sold in their original form without any further expenditure for preparation
- 2 Those products which require further application of labor to become marketable

By products may be obtained from any one of the five following sources

- 1 Sorting and inspecting raw material the foreign or defective material not being allowed to enter the manufacturing process
- 2 Residues left after the main product is manufactured
- 3 Substances in the purification of the main product
- 4 Substances extracted which are not necessary to the manufacture of the main product
- 5 Items not directly connected with or traceable to the material which enters the manufactured product such as shavings sweepings, ashes and exhaust steam

**JOINT PRODUCTS DEFINED**—Joint products represent two or more products separated in the course of the same processing operations usually requiring further processing each product being in such proportion that no single product can be designated as a major product. According to Fox (N. A. C. A. Bulletin vol 15), "joint or multiple product operations are those in the course of which several products are produced production being in such proportions that no single commodity can be designated as a major product."

**Illustrations of Joint Products**—The flour milling industry allocates costs on two theories under the first treatment commodities other than patent flour are classed as by-products under the second treatment the total manufacturing cost is prorated over all products which thus become joint products. In the oil industry gasoline fuel oil lubricants paraffine wax coal tar asphalt and kerosene are all produced from crude petroleum. These are joint products though before the demand for gasoline was popularized through the automobile kerosene was the main product. In the slaughter of hogs the carcass is cut into ham ribs bellies shoulders loins butts etc. These are joint products.

Other instances of joint products occur according to Fox (N. A. C. A. Bulletin vol 15) in industries where **different grades** of same product are obtained.

Many of the Tariff Commission's investigations involved this type of joint product. Thus in its glue investigation the Commission found as many as 21 different grades of hide glue were produced the highest grade requiring least processing of raw material and accordingly made at the lowest cost each subsequent and poorer grade requiring additional processing and therefore added cost. But to establish the costs of grades was on the basis of available records practically impossible.

Other instances of the production of different grades of the same product are found in lumber milling fruit canning tobacco leaf grading, etc.

Fox also presents a summary of **cost reports** published by the Tariff Commission under section 315 of the Tariff Act of 1922 and section 336 of the Act of 1930 and under the general investigatory powers of the Tariff Commission, which yields the following list of investigations wherein significant problems of joint costs and by product costs were encountered.

**Process Joint Products**

Methanol—methanol acetate of lime charcoal  
 Linseed oil—linseed oil and cake  
 Dried egg products—egg yolks and whites  
 Wheat and wheat products—flour and mill feeds

**Raw Material Joint Products**

Casem—evaluation of skim milk  
 \*Creosote oil—evaluation of coal tar

**Joint Production of Grades** (which for the special purposes of the Tariff Commission it becomes necessary to segregate)

Peanuts  
 \*Red cedar shingles  
 Burrwood pipes

**By Product Credits**

Barium carbonate  
 Fluorspar—lump spar  
 Onions—culls  
 Corn—fodder and cobs  
 \*Copper—gold silver and other metals  
 Milk and cream—skim milk  
 Flax upholstery tow—bran and flaxseed

\* Reports under the general investigatory powers submitted to the Congress  
 not cost of production reports under the flexible provisions of the Tariff Act

## Methods of By-Product Accounting

**PROBLEMS TO BE CONSIDERED**—It should be noted that the meat-packing, chemical, oil, coal and fine cotton industries are all continuous process industries and by products are found mainly in these industries rather than in job order or the assembly type of manufacture. Therefore job order cost systems are not as prevalent in accounting for by-products as are process cost procedures.

In attempting to develop proper methods of by-product accounting, the following points must be given consideration:

- 1 Methods of determining costs of by products
- 2 Methods of determining costs of joint products
- 3 Valuation of by products
- 4 Valuation of inventory of major by products and joint products

There are several generally accepted methods of accounting for by-products:

- 1 Net sales of by products treated as "Other Income" on profit and loss statement
- 2 Total sales less total costs
- 3 Total cost less revenue from sale of by products
- 4 Total cost less value of by products (including selling and administrative expense)
- 5 Total cost less value of by products (including subsequent costs and selling and administrative expense)
- 6 Total cost less by products valued at standard cost
- 7 Proration of joint costs

**OTHER INCOME METHOD**—In this cost procedure income arising from the sale of by-products less sales returns may be recorded in one general account or separate accounts may be opened depending

upon the variety of by products sold and the extent to which management wishes to go in obtaining data for analysis. Net sales of by-products are closed into the current Profit and Loss account and appear in the 'Other Income' or 'Miscellaneous Income' section of the profit and loss statement.

It can hardly be said that this procedure for handling of by-products constitutes a cost method since no attempt is made to ascertain their cost. Its use is confined to those industries where

- 1 The value of the by product is unimportant and management's interest is in net results rather than close analysis
- 2 The use of a more detailed method entails too much expense in comparison to benefits derived
- 3 No clearly defined basis of separation appears and where the carrying of the by product with the main product does not entail any appreciable difference in the cost of the main product

The outstanding criticism of this method of accounting for by products is in connection with **valuation of inventories** for balance sheet purposes. Normally no value is given to the by-product inventories which results in an overstatement of major product inventory. If this method is used, the market value of the by product inventories should be shown for purposes of information as a footnote to the balance sheet. A second criticism of this method arises in connection with the treatment of **sales of by products**. As indicated no entry for by-products is made at the time of production, the entry being made only at the time of sale. Unless production of by-products and its sales occur in the same accounting period a true cost history does not exist. A third criticism of this method arises in connection with its simplicity. Since under this method of accounting no attempt is made to control the inventory of by products **losses due to fraud** may be an important factor. Thus under this method all costs and expenses are charged to the **main product**. This is the least scientific method. Even where the by product values involved are small their inclusion as nonoperating income tends to distort the entire picture of operating results. An illustration follows:

Sales of main product (1 000 units at \$10)		\$10 000
Cost of sales		
Produced (1 200 units at \$8)	\$0 600	
Less inventory of main product (200 units at cost 1/6 of production cost)	<u>1 600</u>	<u>9 000</u>
Gross profit		\$ 2 000
Selling and administration expenses		<u>500</u>
Operating income		\$ 1 500
Other income		
By product sales (1 000 units at \$60)		<u>600</u>
Income for Period		<u>\$ 2 100*</u>

\* For purposes of illustration it is assumed that there is a by product inventory valued at \$400 which would appear as a footnote to the balance sheet.

**TOTAL SALES LESS TOTAL COSTS**—This is a variation on the first method. Costs of all products are subtracted from sales of all products. Illustration:

Sales of all products		
1 000 units main product at \$10	\$10 000	
1 000 units by product at \$60	600	\$10 600
Cost of sales (as in first illustration)		8 000
Gross profit		\$ 2 600
Selling and administrative expense		500
Net income for period		<u>\$ 2 100*</u>

\* For purposes of illustration it is assumed that there is a by product inventory valued at \$400 which would appear as a footnote to the balance sheet

**TOTAL COST LESS REVENUE FROM SALE OF BY PRODUCTS**—The first two methods discussed above may be varied by treating the proceeds from the sale of by products as a deduction from the cost of the main product. This method is practically identical with some of the procedures in accounting for waste, scrap and spoilage. Illustration

Sales of main product (1,000 units at \$10)		\$10 000
Cost of sales		
Produced (1 200 units at \$8)	\$9 600	
Less by product sales (1 000 units at \$60)	600	
Net cost of major product	\$9 000	
Less inventory major product (200 units, at cost 1/0 of net cost)	1 500	7 500
Gross profit		\$ 2 500
Selling and administrative expense		500
Net profit		<u>\$ 2 000</u>

Note that the result is not the same as in the prior illustrations. This is because the deduction of by product sales from total production cost yields a different main product cost and hence a different basis on which to calculate the inventory value of the major product. The basic assumption is that by-product revenue reduces the cost of the major product, and because of the close analogy to waste and scrap accounting it is favored by some accountants.

An excellent example of the above method is found in the case of vegetable oil refining. The raw material entering into the refining process is crude or unrefined vegetable oil as produced by the crushing mill. The first operation is refining of the oil, which produces the major product, refined vegetable oil, and a residual by-product 'foots,' which has a commercial value being largely used in the manufacture of soap. The second operation includes bleaching and deodorizing of the refined vegetable oil. Characteristic of these operations is the very narrow margin between the cost of the crude oil and the value of the refined product. Hence, the markets for these two products naturally tend to show a differential equal to the average cost of refining. In addition the two markets are highly sensitive and are apt to fluctuate sharply. Concerns engaging in these lines usually provide for accounting of the refining operations, separate from the results caused by changes in the value of either crude or refined products.

Fig 2 illustrates a typical cost statement for a coconut refining plant taken from Bliss (Management Through Accounts)

	Weight lbs	Amount
Crude oil cost at \$03 per lb	60 000	\$4 800 00
Add factory operating and overhead expenses		80 02
Total costs incurred		\$4 880 02
Deduct by-product foods (11% fatty acids 87% oil weight at \$06)	6 900	302 28
Amount of oil produced at cost	52 800	\$4 524 64
Net shrinkage 2%	300	
Weight of unbleached refined oil	52 500	
Cost per cwt		\$ 8 62

FIG. 2 By-Product Value Deducted from Total Costs

The same method is found in the manufacture of colic as explained by Sheppard (N. A. C. A. Bulletin, vol. 4)

Coil (1 000 tons at \$4 per ton)	\$1000
By-products recoverable	
Lard (12 000 gals at \$.05 per gal)	\$ 600
Sulphate of ammonia (26 000 lbs at \$.02½ per lb)	650
Gas (7 000 000 cu ft at \$.15 per thousand cu ft)	1 050
Benzol extraction (3 000 gals at \$.20 per gal)	600
Total value by-products recoverable	2 900
Colic material cost	\$1100
Carbonizing costs (1 000 tons at \$1 per ton)	1 000
Furnace colic (660 tons at \$.18 per ton)	\$2100

Under this method of accounting, any by-products on hand at the inventory date are valued at the market price of that date less the estimated cost of marketing (see description later in this section.)

The same method as described above is used in the corn products industry, the corn is divided, by a number of cooking and refining processes, into some twenty or thirty different products. The first process or series of processes is known as the wet starch process in it grain is steeped and cooked to the point where it may be separated into its main elements. Of these, the largest in bulk and value is starch constituting most of the inside white kernel. Other elements are hulls and gluten which are developed mostly into cattle feeds or fertilizers and oil which is expressed from the mass. Oil is relatively small in quantity but is the most valuable product per pound weight.

Oils and feeds are commonly treated as by-products or residues and are valued at going market values, leaving other costs to rest upon starch and the products derived from it. The way in which this is done is to have a By-Products account in which are credited the sales amounts for gluten feed, crude oil and oil meal. To this account are debited the beginning inventory and all expenses of processing the by-products after separation from the wet starch. On the credit side is also entered the market value of inventories of these by-products on hand at the end of the period, which, of course, is brought down as a



debit balance in the same account for the next period. The balance of the entire By-Products account then represents the net proceeds of by-products that is, the excess of their sales value over the separate cost of processing them. This account is then closed out by a debit to the By-Products account and a credit to the Wet Starch account for the balance shown which is assumed to be the value of that part of materials which has gone into by-products.

The other product resulting from the wet starch process is raw starch and this is used in making various prepared starches, glucose, and sugar. All starch used for these purposes is credited to the Wet Starch account and debited to the appropriate product cost account at a flat rate per pound, representing the cost of production for that month after giving credit for the net proceeds of the by-products. The real problem of the producer in this connection is to watch market prices of these various sugars and starches to see which of the products are selling at the best prices and will therefore yield the greatest profits. Since raw starch as derived from the wet starch process may be used for any one of these products it is naturally converted to those products which currently show the best return.

**TOTAL COST LESS VALUE OF BY PRODUCTS (Including Selling and Administrative Expense)**—Here there is still no separation of production costs either before or after point of "split-off." But proceeds from sale of by-products are charged with selling and administrative expense connected with the handling of the by-product, the net yield obtained is credited to the cost of the main product. This method is fairly common. Illustration:

Sales of main product (1 000 units at \$10)		\$10 000
Cost of sales		
Produced (1 200 units at \$8)		\$9 600
Less by-product value		
Sales of by-product (1 000 units at \$ 60)	\$600	
Selling and administrative expense (assumed)	80	520
Net cost of main product		\$9 080
Inventory main product (1/6 of net cost)		1 513
Gross profit		<u>7 507</u>
Selling and administrative expense	\$ 500	\$ 2 413
Less amount allotted to by-product	80	420
Net income		<u>\$ 2 013</u>

Note that gross and net profits again vary because of the shifting base on which the inventory value of the main product has to be computed.

**TOTAL COST LESS VALUE OF BY PRODUCTS (Including Subsequent Costs and Distribution Expense)**—This method is an improvement over the prior methods by charging the by-product for selling and administrative expense and also for production costs subsequent to the split-off point. In the manufacture of coke for instance, the main product (coke) is charged for all costs up to the split-off point, and subsequent costs are charged to each product as incurred. The net yield of the by-product (sales less costs) is then treated as a reduction in the cost of coke produced. Simple cost classifications make possible the determination and allocation of subsequent costs.

In Fig. 3 it is assumed that the **joint cost** is \$8,500, and the subsequent costs are \$500 for the main product and \$600 for the by-product. These figures make up the total **production cost**, which is therefore the same as in previous illustrations. Since the joint cost is charged entirely to the main product, the by-product inventory when valued at cost carries only subsequent costs. Thus the unit by-product inventory value is \$600 divided by 2,500 units, or \$24. This is the figure used in valuing the inventory of the by-product in the illustration.

Selling and administrative expenses are charged only against by-products actually sold. If distribution costs are to be charged against the inventory of by-products, further complications arise. Note that the by-product inventory in the illustration has been taken up on the books.

Sales main product (1,000 units at \$10)		\$10,000
Cost of sales:		
Joint cost (charged to main product) (1,200 units)	\$8,500	
Subsequent costs main product (1,200 units)	500	
Total charges to main product	\$9,000	
Less net yield from by-product:		
By-product sales (1,000 units at \$60)	\$600	
By-product inventories (1,500 units at cost \$24)	360	
Total by-product values	\$960	
Less subsequent cost to produce (2,500 units)	\$600	
Selling and administrative expense	80	
Total costs and expenses	\$680	
Net yield of by-product	280	
Net production cost of main product (1,200 units)	\$8,720	
Less inventory main product (200 units at cost)	1,453	
Cost of sales main product		7,267
Gross profit		\$ 2,733
Selling and administrative expenses	\$ 500	
Less amount allocated to by-product	80	420
Net income		\$ 2,313

FIG. 3. By-Product Yields Deducted from Joint Costs

This method is found in the case of gas manufacture. The Uniform System of Accounts for Gas Corporations adopted by the National Association of Railway and Utilities Commissioners provides for two accounts as follows:

**713 Residuals Produced—Credit**—This account shall be credited and the appropriate Stock account charged periodically, with the estimated value of residuals produced. Separate subaccounts shall be maintained for each kind of residuals.

**NOTE:** If the net amount realized from the sale of residuals is greater or less than the amount at which they were originally credited an adjusting entry should be made crediting or charging this account and charging or crediting the 'Stock' account with the difference.

**714 Residuals Expense**—This account shall include all expense incurred in preparing and handling residuals for sale together with the cost of making deliveries.

**NOTE** This account should be divided in such manner as to show the expense applicable to each kind of residuals.

The net amount of these two accounts, representing the net yield of by products operates to reduce the cost of producing the main product.

The beef packing industry furnishes the most outstanding example of using the net yield on by products to reduce the cost of the main product. Special interest attaches to by-product accounting in this industry because of the great variety of products resulting from operations and the complexity of the processing. The flow chart shown in Fig. 4 taken from *Packinghouse Accounting*, traces the operations and

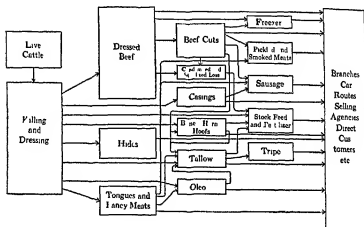


FIG. 4 Flow Chart

products from the live cattle stage to the final sale of the products. The relation of this chart to the ledger accounts is clearly shown in Fig. 5 taken from Bliss (*Management Through Accounts*). It shows the flow of costs beginning with the Live Cattle account through the killing and dressing department and thence to the dressed beef department. The relation of by products to other accounts is also shown.

Figs. 6 and 7 show the net yield of by-product deducted from main product cost. Fig. 6 shows how cost per hundredweight of dressed beef is arrived at for each lot. A more detailed illustration is shown by Greer in Fig. 7 (*N. A. C. A. Bulletin* vol. 17).



Live cost (46 heads weight 52 390 lbs, average 1139 lbs each native steer at \$7 per cwt)	\$3 667 30
Expenses—killing, dressing, chilling, (estimated for month)	118 03
Allowance—condemnations trimming, etc (average)	17 77
Total outlay on lot	\$3 803 10
Less credit for hides (cured value less expense of curing and marketing)	\$ 387 00
Less credit for fats (value of products less expenses)	110 30
Less credit for other by products (value of products less expenses of preparation)	125 73
Total by product credits	\$ 629 00
Balance—plant cost of carcasses in cooler	\$3 174 01
Dressed carcasses (weight 29 615 lbs yield 56 53% of beef)	
Average dressed cost per cwt	\$ 10 72
Add selling costs and expenses	1 87
Total cost of lot per cwt of dressed beef	\$ 12 59

FIG 6 Figuring Costs in Beef Packing Industry

No of head <u>30</u>	Total live weight <u>31360</u> lbs	Avg live weight <u>1112</u> lbs
Grade, <u>good</u> steers	Bought from <u>Q Co</u>	Date <u>March 27 19</u>

	Weight lbs	Total Cost	Cost per Cwt Alive
LIVE BASIS			
Live cattle cost	31360	\$ 135 04	\$6 40
Expenses			
Killing and dressing (at \$2 15 per head)		64 50	19
Cooler (at \$ 20 per cwt dressed)		66 30	17
Total cost and expense		\$2 755 84	\$6 76
By product credits			
Hides Schedule 1	2100	\$ 121 15	\$ 36
Fats Schedule 2	1730	47 67	13
Other items Schedule 3	2146	90 95	27
Total credits	5536	\$ 259 77	\$ 76
Net cost		\$2 001 12	\$6 00
		Cost per Cwt Dressed	Yield
DRESSED BASIS			
Cost per cwt dressed	10415	\$ 10 31	58 2%
Allowance for cooler trim etc	155	08	5
Total cost of salable beef	10260	\$ 10 39	57 7%

FIG 7a Detailed Cost Calculation in Meat Packing Plant

		Hides	(Schedule 1)		
	No	Green Weight Lbs	Cured Weight Lbs	Price per Cwt	Value
Heavy hides	20	1 456	1 104	\$ 8 25	\$ 98 51
Heavy hides branded	5	364	298	6 75	20 12
Light hides	5	340	279	7 25	20 35
	<u>30</u>	<u>2 160</u>	<u>1 771</u>		<u>\$138 86</u>
Expense (1771 lbs cured weight at \$1 per cwt)					17 71
Net value of hides on killing floor					<u>\$121 15</u>

Fats		(Schedule 2)		
Total fats (820 lbs cowl and ruffic fat plus estimated 410 lbs addl blinn <sub>g</sub> fats = 1230 lbs total weight of raw fats)				
Estimated yields				
Olco oil at 70% of raw fats	861	\$ 5 75	\$ 40 51	
Tallow at 10% of raw fats	<u>123</u>	<u>4 00</u>	<u>4 92</u>	
	<u>984</u>		<u>\$ 45 43</u>	
Expense (984 lbs rendered weight at \$120 per cwt)				\$ 11 81
Net value of fats on blinn <sub>g</sub> floor				<u>\$ 33 62</u>

Miscellaneous By Products		(Schedule 3)			
Edible items					
Longines	229	\$11 00	\$ 25 08		
Feet	26	12 50	30 75		
Heads	116	4 00	4 64		
Tails	34	10 00	3 40		
Sweetbreads	11	16 00	2 24		
Brains	25	5 00	1 25		
Head and chisel meat	161	3 00	4 83		
	<u>904</u>		<u>\$ 82 19</u>		
Expense (904 lbs at \$1 per cwt)				9 04	
Net value of edible items				<u>\$ 73 15</u>	
Inedible items					
Bones, horns and hoofs	447	\$ 3 00	\$ 13 35		
Grease	183	2 50	4 58		
Laugo	614	1 50	9 21		
	<u>1 242</u>		<u>\$ 27 14</u>		
Expense (1 242 lbs at \$80 per cwt)				9 94	
Net value of inedible items				<u>\$ 17 20</u>	
Total miscellaneous by products				<u>\$ 90 35</u>	

FIG 7b Calculating By Product Credits

The raw material purchased is the live animal, the major product is dressed beef, by-products consist of hides edible fats, and a variety of other edible and inedible items. Under the usual cost accounting practice followed by the industry, the cost sheet on a test lot shows

- 1 Total amount paid for live cattle
- 2 An allowance for expenses normally incurred in the slaughtering and dressing process and in chilling and temporary storage of dressed beef. Expense figures used are based on previous average experience, possibly with some adjustment for any differences in current wage rates volume of production or other factors

By product credits are arrived at as illustrated in Schedules 1, 2, and 3. Note that some figures are taken from actual weight or measurement of by-products produced from this particular lot, while other figures are estimated on the basis of **normal experience**. For example, the so called "green weight" of hides may be determined by actual weighing as the hides leave the killing floor, but the cured weight which is finally available for sale must be estimated on the basis of the past experience. Similarly, some fats can be weighed at time of the slaughtering operation while others are recovered at such other times and places that it may not be practical to take their actual weights an estimate being necessary. The amount of yield of edible and inedible oils also must be estimated, and of course expenses to be incurred are entirely matters of estimate. When the calculation has been completed, the **net value of all by product items** is combined into one total and deducted from the aggregate expenditure previously recorded. The resultant net cost is allocated to the major product, dressed beef. A further calculation is necessary to convert cost per hundredweight alive into a cost per hundredweight dressed, due allowance being made for the initial yield of dressed beef and for subsequent losses which may take place due to shrinkage, trimming in coolers, etc. This cost ultimately is measured against the selling value of dressed beef to determine the profit or loss on the operation.

Under the above procedure **profit or loss** should appear only in the account for sales of dressed beef since by-products have been set up on the books at a theoretical net recoverable value. As a matter of fact, the procedure does not lead to the elimination of all profit or loss on by-products, since many computations are estimates and actual experience often is somewhat different. For example the net amount of each by-product recovered may be somewhat more or less than was estimated, the price at which it is finally sold may be above or below the price used in the cost calculation and the expense of processing may be greater or less than was anticipated. Thus the by-product accounts typically do contribute some additional profit or loss to the amount figured on the major product.

**Replacement Cost Method**—A special application of by-product accounting where net yields are subtracted from joint costs is found in steel manufacture. In this case net yields are not always assigned to the by products, since many of them are utilized within the plant. Hence they are valued at the cost of purchasing or replacing the products in question. The manufacture of steel involves a number of successive processes in each of which there is a major product and one or more by-products. The distinguishing feature with respect to by-products is

the recovery of a number of substances which are not sold as such but are used wholly or partly in other manufacturing processes. Fig. 8 taken from *Gases* (N.A.C.A. Bulletin vol. 17) shows by means of a diagram the principal processes and some of the more important products and by-products recovered. The major line of processing proceeds through the manufacture of coke, production of pig iron in blast fur-

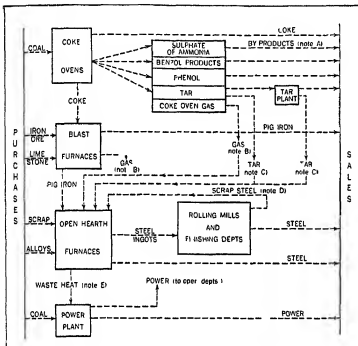


FIG. 8 By Product Accounting Treatment and Flow Chart  
(Courtesy of L. D. Clegg, Chicago)

naces, and production of steel ingots in open hearth furnaces to rolling of ingots into rails, bars, sheets, and structural shapes.

Some of the most important by products are recovered in the manufacture of coke, and the typical large steel plant has extensive processing departments devoted to the recovery and further processing of these by-products (sulphate of ammonia, benzol, phenol, tar, etc.). Many of these by products are sold. On the other hand, blast furnace gas, coke oven gas and some tar derivatives may be mixed and used for heating, in open hearth furnaces, waste heat from open hearths is used in the



	By Product Cost	Joint Cost	Subsequent Costs	
			Main Product	By Product
Selling price	\$6,250 00		\$20 250 00	
Less mark up on by product				
Selling and administrative expense (5% of selling price assumed)	\$ 312 50			
Net profit (15% of selling price assumed)	937 50			
Total deductions	\$1 250 00			
Total cost of by product	\$5 000 00			
Production costs				
Material		\$ 8 000 00	\$ 800 00	\$ 300 00
Labor		6 000 00	1 000 00	400 00
Manufacturing expense		4 000 00	600 00	100 00
Joint cost to split-off point		\$18 000 00	\$ 2 400 00	
Subsequent cost of main product	800 00			
Subsequent cost of by product (deducted from total by product cost)				\$ 500 00
Value of by product at split off point (deducted from joint cost)	\$4,200 00	4 200 00		
Cost of main product (at point of split off)		\$13 800 00	13 800 00	
Total cost of main product			\$16 200 00	
Gross profit on main product			\$ 4 000 00	
Selling and administrative expense		\$ 1 325 00		
Less amount assigned to by product		312 50	1 012 50	
Net profit on main product			\$ 3 037 50	
Pounds of main product			700	
Cost per pound of main product			\$ 21 50	

Fig 9 Reverse Cost Method

generation of steam, which is converted into power for use by various operating departments, scrap metal recovered in various processes is remelted to produce new steel ingots, etc.

According to the source cited above, the references to the various notes in Fig. 8 cover the following methods of by-product accounting used by one large steel company:

- A Coke oven by products credited to cost of coke at the average sales price per unit for the month
- B Coke oven and blast furnace gas credited respectively to cost of coke and cost of pig iron at computed value based on cost of fuel oil yielding equivalent heat units
- C Lignite and pitch used as fuel credited to cost of coke at computed value based on cost of fuel oil yielding equivalent heat units
- D Scrap steel remelted credited to cost of finished steel at market cost of equivalent grades purchased
- E Waste heat from furnaces used to generate steam credited to steel ingot cost at computed value based on cost of coal yielding equivalent heat units

Note that in some instances the values are those recoverable on the sale of products, while in others they are the equivalent costs of similar products if purchased independently for use in manufacturing processes.

**Reverse Cost Method**—Fig. 9 illustrates the so called method of working backwards, also called the reverse cost method. This is in effect equivalent to the method described above where the net yield from the by-product is deducted from total costs. But it may be used also to determine the amount of cost it is economically possible to allocate to the main product. This is done by deflating the selling price of the by-product by an assumed gross profit margin (to cover estimated net profit and selling and administrative expenses) and by the production costs subsequent to the split off point. The net amount deducted from the joint costs represents the main product's share of the joint cost. In Fig. 3 the by-product yields are assembled and deducted from the joint costs. The result is the share of joint cost allotted to the main product. In this way a unit cost for the main product may be obtained by dividing the calculated cost by the yield. The net profit obtained is of course exclusive of the profit on the by-product.

An excellent example of the **reverse costing method** is found in the case of accounting for cottonseed processing costs. The processing of cottonseed involves the production of

- |                   |           |
|-------------------|-----------|
| 1 Cottonseed oil  | 3 Hulls   |
| 2 Cottonseed meal | 4 Linters |

The chief problem is the determination of the fair price of cottonseed, that is the price that the miller can afford to pay for cottonseed. The method of calculating the price of cottonseed is essentially one of working backwards—that is milling costs are deducted from the total values of products obtainable from a ton of cottonseed. These values depend on the yields of the several products. A sample calculation was made in 1929 by the National Cottonseed Products Association and the Southern Cotton Oil Company from which the following information is abstracted:

**OIL.** An average ton of good seed produces 315 lbs of crude cottonseed oil. The actual quantity varies from 280 to 345 lbs per ton of seed. The price of cottonseed oil is governed by the market for other oils and fats such as lard.

315 lbs at 7½ cents per lb \$23 20

**MEAL.** An average ton of good seed produces 950 lbs of cottonseed meal. The quantity of meal which can be produced from a ton of seed varies according to the character of the seed and also according to the grade of meal which it is desired to produce. The market price of meal is also governed by the law of supply and demand just as the market price of oil is and depends largely on the market price of other concentrated feeds and ammoniates.

950 lbs at \$32 a ton loose (\$33 50 sacked, the sacks cost \$1 50 a ton) 15 90

**HULLS.** The quantity of hulls produced per ton of seed varies according to the quantity and quality of meal that has been produced. The average yield is 500 lbs. The market value is affected by competition of other products used as roughage in feeding livestock, such as hay.

500 lbs at \$3 50 per ton 2 12

**LINTERS.** The quantity of lint produced also depends on the character of seed and kind of lint it is desired to produce. The market price is governed largely by the market price of other bedding materials and cost of wood pulp with which linters are in competition in the production of rayon.

110 lbs at 2 cents per lb 2 20

The total of these products amounts to 1 875 lbs the loss of 125 lbs in weight being sand trash and moisture and other manufacturing loss.

Total value of products from an average ton of seed \$43 87

To the material cost of the mill must be added handling and other expenses in the form of commissions paid dealers who collect seed in car load lots take care of weight discrepancies, and transport it to the oil mill. The processing costs consist of costs incurred in performing the following operations:

- |             |            |
|-------------|------------|
| 1 Unloading | 4 Hulling  |
| 2 Cleaning  | 5 Cooling  |
| 3 Delinting | 6 Pressing |

Using same illustration as above, the cost per ton is as follows:

Labor	\$ 2 10
Repairs and maintenance of running machinery	00
Steam and power	1 20
Press cloth	25
Chemical analysis cleaning up and other miscellaneous expense	20
Interest on the money invested in seed and in products not yet marketed	00
State city county school and other similar taxes (exclusive of federal income tax)	30
Insurance on buildings machinery stock and accidents	25

Interest on capital invested in land buildings and machinery of oil mill	1 00
Wear and tear on buildings and machinery and cost of replacing them when obsolete or worn out depreciation	75
Cost of manager superintendent cashier and other traveling help	1 50
Telegraph telephone stationery printing and other expense	1 10
Total processing cost	<u>\$10 75</u>

According to the figures submitted by the associations mentioned above, a summary of costs to the mill is as follows:

Processing cost	\$10 75
Handling cost	
Commissions etc	\$3 00
Transportation	<u>2 00</u> 5 00
Total cost	\$15 75
Total value of products	<u>43 82</u>
Balance	<u>\$28 07</u>

This, according to the sources cited, represents the maximum that the oil mill can afford to pay for a ton of cottonseed if the oil mill operated without any profit. That these figures are open to some criticism is evident from the following observations made by Walton Hamilton (*Price and Price Policies*):

This sample computation for arriving at seed prices through deducting mill spread raises a number of questions concerning the items included in spread or mill conversion costs. In the first place it should be noted that two interest items are included totaling \$2 20 or about an eighth of the total milling costs. The first interest on money invested in seed and products is to a considerable extent fictitious and should be considered as profit while interest on capital invested is probably a profit item. Whether profits should be included in costs what proportion of the total they should form if included and even the size of the other items seem to be rather arbitrary matters. Apparently no uniform system of cost accounting has ever been used by the industry.

Another illustration of this method of cost assignment is found in flour milling. The flour milling industry involves the production of three types of products: high-grade flour (the standard grade) low-grade flour, and culls (which include bran shorts middlings screenings, etc.). Standard grade flour is usually considered the major product and the other items are by-products.

All costs of manufacture are charged to high-grade flour produced which is in turn credited with the total selling value of by products. Fig. 10 taken from Nasher (*NACA Bulletin vol 3*) presents a method of costing flour and its by-products. The total value of all by products is deducted from the total wheat cost after milling to arrive at the cost of milling first patent flour. This cost is then adjusted to the equivalent of milling one barrel of first patent flour. Added to this cost are packaging selling and administrative charges which finally give the total cost of one barrel of first patent flour (196 pounds). Essentially the same method is employed by Peley (*Journal of Accountancy vol 68*).

**OIL** An average ton of go touseed oil The actual ton of seed The price let for other oils and f

**Computing the Cost of a Barrel of Flour**  
 1 bush which equal 276 lbs of wheat yields 14 lbs of first grade flour and 80 lbs of offal

315 lbs at 7% cent

**MEAL** An average ton of meal The quantity of seed varies according to the grade market price of meal demand just as the on the market price

10 lbs of offal are divided into 10 bags

950 lbs at \$1.50 a t

10 bags taken from the wheat

**HULLS** The grinding

Assumption puts the average wheat cost per bushel including elevator charges, at \$1.50

Then the cost of grind may be stated thus

4 bushels of wheat at \$1.50

Milling expenses

Total

\$6.00  
 .50  
 \$7.40

Which is reduced by the selling price in bulk of the low grade flour and offal produced thus

Standard flour	29 4 lbs	\$ 7.20 per barrel	\$1.08
First clear	19 6 "	\$ 5.00 "	.50
Middlings and bran	72 0 "	\$25.00 "	.00
Screenings	8 0 "	\$10.00 "	.04
	129 0 "		

The total credit of by products, at the above assumed selling prices being

2.52

Leaves the milling cost of 147 lbs of first patent flour at

\$4.88

Thus making the milling cost of one barrel equal to

\$6.50

To which add average cost of package

.40

Also add selling and administrative expense

\$ .70

Total packaged cost

6.60

Total cost of one barrel of first patent flour

\$7.60

FIG 10 Computation of Flour Costs

Chandler of the Millers' National Federation, shows a somewhat different approach. In the above illustration the cost of production (milling expense) is added to the cost of the wheat and the total reduced by the selling price of the various by products. In Chandler's calculation the mill feed credit is applied against the cost of the wheat and production and distribution costs are added on to the cost of 100% flour. However according to Chandler, the net value of mill feed is calculated by deducting from the current selling price of feed an allowance for handling, shipping, and selling expense, including a safety factor leaving a net by-product value to be used as explained above. This use of a safety factor is explained by Greer (NACA Bulletin, vol 17) as follows

The value assigned to mill feed normally would be the amount for which it can be sold less the expense of selling, handling, shipping and delivery. Since the amounts are variable and since the market price of feed may change before a sale is made the management strives for a conservative by-product credit to prevent the overvaluation of the by-product and consequent underestimate of costs applicable to the major product. Thus an arbitrary safety factor sometimes is introduced into the calculations of by-product value to provide against fluctuations in market price and unexpectedly heavy distribution expense.

### TOTAL COSTS LESS BY PRODUCTS VALUED AT STANDARD COST

Under the first three methods discussed above the values assigned to by-products were proceeds from sale, i.e. current market value. If fluctuations in the value of by-products occur it is difficult to determine whether the resulting cost fluctuations are due to variations in the costs of the main product or of the by-product. Hence the suggestion is made to credit Work in Process for by-product values at a standard price. The standard may be an arbitrary figure or may represent the average price over a period of time but it presumably represents an effort to stabilize the market value of by-products. According to Sanders (Cost Accounting for Executive Control) the effect of the market value method is to let "all fluctuations in cost rest on the major product. If the selling price of the by-product increases it will show enhanced profit without any increase in cost; also, the cost of the principal product may vary without a corresponding change in the selling price." Thus a fictitious showing is produced as illustrated by Fig. 11. The latter clearly shows that fluctuations in joint costs are reflected in the major product with added emphasis. An increase of 5 cents in the price of raw material gives an increase of 72 cents in the price allocated to the major product.

	CASE 1	CASE 2	CASE 3
a Value per pound of materials at joint value subdivided	30¢	27¢	2¢
b Pounds of materials processed	2,000,000	2,000,000	2,000,000
c Value of materials processed (a × b)	\$600,000	\$540,000	\$400,000
d Pounds of subproducts resulting	800,000	800,000	800,000
e Standard cost adopted for subproduct	12¢	17¢	10¢
f Value allocated to subproduct (d × e)	\$ 72,000	\$ 72,000	\$ 79,000
g Remainder value of main product (c - f)	\$528,000	\$468,000	\$321,000
h Pounds of main product materials (b - d)	1,400,000	1,400,000	1,400,000
i Value per pound main product (g - h)	37.7¢	33.4¢	23.0¢

FIG. 11 Effect of Valuing By Product at Standard Cost

The following is an illustration applied in the manufacture of counters and innersoles, adapted from an article by Nickerson (N. A. C. A. Bulletin vol. 14). Counters are leather forms fitted on the inside of the heel of a shoe, and are considered the major product. Innersoles, considered a by-product, are cut from leather in various sizes and then finished. The company in question usually purchases the entire part of the hide known as the belly, that is the part below the bend and shoulder (Fig. 12).

Counters are cut from belly centers, the latter are considered the main product at the time bellies are cut into sections. Values are

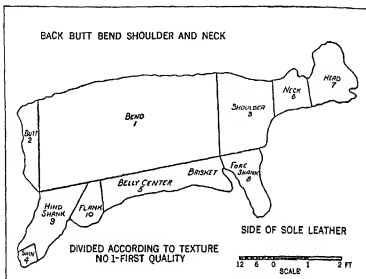


FIG 12 Diagram of Parts of Hide

assigned to all sections except the centers. The total values assigned are subtracted from the total lot cost, and the balance represents the cost allocated to the centers. **Standard allowances**, representing savings incurred in buying the whole belly, are also set up and are subtracted from the current prices of the various sections. The figures below are based on an assumed purchase of 500 pounds of bellies at \$13 or a total purchase value of \$65. After cutting, the following results are obtained:

Section	Pounds	Current Market Value	Deduct Standard Allowance	Standard Cost per Pound	Net Value of By Products
Hind shanks	150	\$ 12	\$ 01	\$ 11	\$16 50
Fore shanks	110	09	005	085	9 35
Flanks	60	08	005	075	4 50
	<u>320</u>				<u>\$30 35</u>
Total cost of lot					\$65 00
Values assigned as above					30 35
Assumed cost of centers					<u>\$34 65</u>
Pounds of centers cut					180
Assumed cost per pound for centers					\$ 1925

Cost of labor in cutting and standard departmental burden charge based on labor cost are charged entirely to centers. This method results in standard profit for sections if they are sold, or a standard reduction

in raw material cost if the sections are used in manufacture of inner-soles. Profits made in this manner are considered operating income, not reduction in cost of manufacturing counters. This cost seems to work to the disadvantage of belly centers but this is not objectionable for the standard reductions are such that the net cost of centers, after adding cutting labor and overhead, is approximately the same as the price at which they can be purchased in the open market.

It is evident that this method is a combination of three methods described earlier in this Section.

- 1 The cost of belly centers is found by subtracting by product yields from the purchase price which is the joint cost.
- 2 A standard value is used in effecting the subtraction.
- 3 Profits from sales are treated as Other Income.

The question also arises as to whether it is better to sell sections or manufacture them into innersoles, this is a matter of executive policy. If innersoles are manufactured, the cost of direct labor, burden, and material, after credit for scrap on each lot is determined. The cost is shown on a per pair basis regardless of size or grade. The innersoles are sorted and counted by grades, and valued at current market prices. The latter minus the lot cost shows the gross profit or loss for the lot.

The material cost of counters and innersoles is allocated on the basis of weight used. Cutting on centers is done only when orders are received at a price in excess of the estimated cost, which is based on the current price for centers plus the estimated conversion cost. In cutting counters a large quantity of innersoles cut from centers is accumulated whose market value is below the computed cost. This cannot be avoided as some parts of the center are not suitable for counters, and complete utilization of the hide demands therefore, the cutting of innersoles. The cutting cost is allocated to counters and innersoles on a per pair basis. Overhead is charged at a standard rate per pair for cutting. Standard finishing charges are also applied to the cut blanks. By comparing total costs with the sales value of the lot a profit or loss figure is obtained. Lot costing is done by the cost department on a memorandum basis, each lot may be costed, or test runs made.

**BY-PRODUCT ACCOUNTING AND MANAGERIAL POLICY**—Accounting treatment of by product credits must be in accord with the needs of management. Sometimes this involves a complete reversal of ordinary accounting procedure, as in the case of the manufacture of linseed oil and meal. This point is illustrated by Greer (N. A. C. A. Bulletin, vol. 17) as follows:

A milling company required a quantity of linseed meal for mixing with its mill feeds. To produce this the company purchased flaxseed which was ground, producing as a major product linseed meal and as a by product linseed oil. At the outset the net current value of the oil was credited to the process, and the residual cost was charged against the linseed meal. Under this procedure the calculated cost of the linseed meal fluctuated with changes in the value of the oil whereas the market price of linseed meal purchased independently did not necessarily fluctuate in a similar manner.

After some consideration the company reversed its accounting procedure, treating the meal as a by product and the oil as the major product. The current market cost of the meal was credited to the process (and charged to the mill feed department) and the remainder of the seed cost



and processing expense was charged against the oil recovered. This resulted in a separate profit and loss account for linseed oil. At any time when the charges thus allocated against the oil could not be recovered through available selling prices, the oil mill was closed down and linseed meal was purchased from outside sources.

**PRORATION OF JOINT COSTS**—Another method of by-product accounting is to charge each product for costs subsequent to the split-off point, and to apportion the joint costs between the major and by-product on some acceptable basis. Some authorities consider this method superior to the others, but there is no logical basis for this view, except the fact that a cost is attached to each product. It is true, however, that in the absence of proration, the resulting costs may be misleading. A lack of detailed cost data makes itself felt in improper inventory values, erroneous sales policies through improper pricing of the product, etc. The method of joint cost proration is identical with joint product accounting discussed in detail later in this section.

**PROFIT AND LOSS STATEMENTS IN BY-PRODUCT ACCOUNTING**—Figures on the profit and loss statement do not always show the exact method of by-product accounting used. Fig. 1 shows three formulas for computing net profits of manufacturing establishments. The first is self explanatory, the second illustrates a form of presentation where by-product values are deducted from total manufacturing costs; the same form may be used irrespective of the basis of valuation of by-products: cost, market value, market value adjusted for selling and administrative expenses, etc. If it is not desired to deduct by-product values from total cost, they may be shown as Other Income. The third formula is readily recognized as a variation of the method of deducting total costs from total sales.

Figs. 13 and 14 present additional variants of profit and loss statements in by-product industries. They also serve to show by-products valued at market, deducted from main product cost. Strictly speaking the deduction is made from total cost, but since all costs are charged to the main product, the treatment is the same. Fig. 13 shows costs for a rice mill as given by White (Journal of Accountancy, vol. 53). A similar treatment for beet sugar mills (Fig. 14) is given by Bliss (Management Through Accounts).

#### STATEMENT OF COST OF RICE PRODUCED

Total cost of rough rice to the mill	\$	
Add cost of milling		
Total manufacturing cost		\$
Less market price of by products		
Screenings	\$	
Brewers		
Bran		
Polish		
Chicken feed		
Hulls		
Total by product credit		\$
Cost of clean rice		

FIG. 13 Calculation of Main Product by Deduction of By Product Values

## FACTORY COST OF SUGAR PRODUCED

	Amount	Per Cent of Sugar
Bags produced		
Piouring and supervising acreage	\$	
Cost of beets		
Operating supplies		
Operating labor expense		
Maintenance and repairs		
Factory expenses		
Current production charges	\$	
Add stock in process at (beginning)		
Total production charges	\$	
Deduct by products		
Molasses	\$	
Pulp		
Total	\$	
Deduct stock in process (ending)		
Factory cost of sugar produced	\$	

FIG 14 By Products Deducted from Total Costs

**SUMMARY OF METHODS**—The first two methods of by-product accounting discussed above, "Other Income" and "Total Sales less Total Costs" cannot be seriously considered as representing a solution of the problem of jointly incurred costs of production, especially since by-product entries are made only at the time of sale rather than at the time of production. The next three methods consisting of adjustments to the joint costs in various forms, are sometimes referred to as **market value methods**.

The net cost of the major product is determined by deducting from total costs the **recoverable values** of the by products. These values are determined in one of the three following ways:

- 1 The estimated market price of each by product is multiplied by the number of units produced or sold which gives estimated revenue from each by product. The income is credited against cost of the major product.
- 2 From the estimated revenue as calculated in (1) above is deducted the estimated marketing and administrative expense applicable to by products. The net return is credited against cost of the major product.
- 3 From the estimated revenue, as determined in (1) above is deducted the manufacturing cost of the by product after it separates from the main manufacturing process and the estimated marketing and administrative expenses applicable to the by product. The net return is credited against cost of the major product.

The logic of the market value method is based upon the concept that **selling values of by-products** are often indicative of their actual cost, and that deduction of this net yield from the cost of the major commodity indicates the true cost of major commodity alone. The method is particularly advantageous in those industries, notably in the meat-packing industry, where there is a definite correlation between the market for raw material and that for finished products. In those

industries, however, in which the selling price of by-products is subject to a supply and demand determination of its own, which exists quite apart from that applicable either to raw materials or to the major product, the bargaining position of the vendor of by-products may have an unwarranted effect upon the calculated unit costs of the major product.

The chief criticism of this method of accounting for by-products is the use of arbitrary estimates in the valuation of by products. The estimates are subject to differences with respect to

- 1 Quantity of each by product which is finally recovered
- 2 Expense which is incurred in marketing and selling the finished by products
- 3 The market price at which the sale is made

Consequently, the account for each by-product is likely to show a small profit or loss representing the variance between actual and estimated results after the by-product has been separated from the main manufacturing process.

Distortions of production costs are likely to result from the inclusion of selling and administrative expenses under some of the market value methods. By pricing by-products at standard values the latter are artificially stabilized but aggravate the cost fluctuations of the main product. Deducting the net yield from the main product cost has the merit of charging at least costs subsequent to the split-off point against the by-product. Fluctuations in production costs, therefore, are reflected though imperfectly, in both major and by-products.

**BY PRODUCT INVENTORY VALUATION**—Where only sales of by-product are recorded, inventories appear as memoranda. Where market values form the basis of entries at the time of sale, the by-products on hand at closing time may be valued at current market price, with or without deduction for estimated distribution costs. This implies that the inventory is valued at market irrespective of cost, if costs are below market value, anticipation of profits occurs. This is particularly true of by-products which have no costs charged against them.

The actual journal entries resulting where total costs are credited for by-product values, including selling and administrative expenses are illustrated below, they are based on the following assumptions

1	Cost of sales (shipments of goods) for the period amounts to	\$1,000 000
2	The value of by products at the end of the period at market is	5 000
3	Estimated selling and administrative expenses (applicable to by products) are	
a	Selling	\$100
b	Administrative	50
		150

### JOURNAL ENTRIES

(1)

Inventory		
Income from By Products	\$5 000 00	
To set up value of by products at end of period unsold at this date (but included in income as books are kept on accrual basis)		\$5,000 00

(2)		
Income from By Products	150 00	
Reserve for Selling and Administrative Expenses		150 00
To set up reserve for estimated costs of disposing of by products		
(3)		
Reserve for Selling and Administrative Expenses	150 00	
Selling Expenses		100 00
Administrative Expenses		50 00
To close the reserve by a reversing entry at beginning of next cost period		
(4)		
Selling Expenses		
Administrative Expenses		
Cash or Accounts Payable		
To record selling and administrative expenses incurred in new period, whether on main or by product		
(5)		
Cash (or Accounts Receivable)	5 000 00	
Inventory		5 000 00
To record sale of by products in next year or period		

### Joint Product Accounting

**METHODS OF JOINT PRODUCT ACCOUNTING**—By definition, each joint product is of equal importance, hence management must try to secure a profit on each one. To do this joint costs must be prorated and subsequent costs properly charged. Generally speaking, there are four basic methods of accounting for joint product costs up to the split-off point:

- 1 Average unit cost
- 2 Apportionment on the basis of some physical unit such as weight, volume, linear measure, atomic weight, heat units, etc.
- 3 Apportionment on the basis of the relative market values of the finished products
- 4 Standard ratio method or fixed fraction method

None of the above methods is thoroughly satisfactory, at any rate, not in all cases. On the whole, the first and second methods mentioned above, in spite of their apparent lack of any scientific attempt to solve the problem of joint costs, are about as satisfactory as any. Certainly, they are the simplest in operation. According to Amidon and Lang (*Essentials of Cost Accounting*), even apportionment of joint costs does not always solve the problem. Speaking of the market value method in the case of a lumber manufacturer who uses waste ends to produce toys, they state:

Apportioning joint costs on the basis of market value is often an uncertain procedure. Under this method, joint products are valued at the market price; the ratio between the two determined; and the joint costs apportioned on that percentage. Such distribution is wholly artificial and may not show the actual state of affairs. The reason is found in the economic laws of demand and supply. Suppose the demand for the main product, such as lumber used for building construction, increases while the demand for toys remains stationary. As the mill increases its production to meet the increased demand, more and more waste is turned out to be

manufactured into toys. The market price of the main product will go up due to the higher demand, on the other hand the selling price of the toys will decline due to the fixed demand accompanied by the increased supply. If then the joint costs are apportioned on the basis of the market value the toys will be made to bear a lower joint cost because the market value of the by product has become less relative to the value of the main product. In reality no such reduction of cost has taken place. It will be seen then that whatever profit or loss is shown for toys under this method is a more or less arbitrary amount.

**AVERAGE UNIT COST METHOD**—Under this method total costs only are figured, yielding an average unit cost and one net profit. Thus average costs are obtained for the production as a whole. This method is valid only in those cases where the resultant products are expressed in terms of the same units. Where the units are not comparable, the method breaks down at once.

The average is used for inventory pricing purposes, but it may also be used for the purpose of allocating joint costs, each product being valued at the average cost in proportion to the quantities produced.

Although the method is not wholly satisfactory, it has a measure of logic behind it. Since all products are turned out by the same process, it is impossible to say that one costs more to produce per unit than the other.

An example taken from the operations of a sawmill illustrates the method.

1 Total production	2 500,000 ft
2 Total cost (joint)	\$53,000 00
3 Average cost per 1 000 ft, (1) — (2)	\$ 21 20

This average is used to cost the various grades produced in proportion to their quantities.

Grades	Quantities Produced (Ft)	Average Cost per 1,000 Ft	Value of Product
First and seconds	250,000	\$21 20	\$ 5,300 00
No 1 common	1,250,000	21 20	26 500 00
No 2 common	500,000	21 20	10 600 00
No 3 common	500 000	21 20	10 600 00
	<u>2 500 000</u>		<u>\$53 000 00</u>

The method has been sanctioned by the Bureau of Internal Revenue in the following ruling:

Tobacco companies taking inventory on the monthly average cost method, no method more nearly approaching theoretical accuracy being possible, may continue to use such method in reporting for income tax.

Regulation 103, Section 19.22(c)-7, states

A taxpayer engaged in mining or manufacturing who by a single process or uniform series of processes derives a product of two or more kinds, sizes, or grades, the unit cost of which is substantially alike, and who in conformity to a recognized trade practice allocates an amount of cost to each kind, size, or grade of product, which in the aggregate will absorb the total cost of production, may, with the consent of the Commissioner, use such allocated cost as a basis for pricing inventories provided such allocation bears a reasonable relation to the respective selling values of the different kinds of product.

The last quoted regulation seems to limit the applicability of the average cost method to those cases where the allocated costs bear a reasonable relationship to selling prices. A strict interpretation of the ruling would make it unworkable, unit costs being the same for each joint product, and the selling prices different. The relation of cost to selling price obviously varies from product to product.

**Application of Average Cost Method**—The tobacco and lumber industries are examples where the average cost method may be employed. In both cases, however, this method is generally disregarded. In the case of tobacco, where the grading is done by the grower, the manufacturer buys graded leaf. He may, however, buy leaf ungraded, at so much a hogshead and then do his own grading. In such a case he usually allocates total cost to the several grades on the basis of their respective market values. (See discussion later in this Section.)

Much the same condition prevails in the lumber industry, as shown in the illustration above. Here costs of different grades of lumber turned out by the same process may be determined on the average cost basis or on a basis of relative market values. Flour milling and the making of glue, etc., in fact all industries in which different grades of the same product are produced by a single joint process, offer the possibility of the use of the average cost method, though few actually use it. In flour milling all costs are charged against the production of high grade flour, lesser grades being treated as a deduction from the total cost. In this way the problem posed by joint cost production is evaded, since the above constitutes merely by-product accounting.

**ALLOCATION OF JOINT COSTS ON PHYSICAL UNIT BASIS**—Under this method, joint costs are distributed to products on the basis of some physical coefficient, i. e., the joint cost is broken up in proportion to the raw materials contained in each product. An illustration is found in the manufacture of coke, in this case costs may be allocated in proportion to the weight of the various products, according to Sheppard (N. A. C. A. Bulletin, vol. 4). The weights of all the finished products are determined, per ton of coal, with the exception of gas, which may be found by subtracting the totals of the other products from 2,000.

Assuming one ton of coal to cost \$4, the following schedule results, showing the apportionment of weight and material cost to each product, the apportionment being made in the ratio that each product weight bears to the total product weight.

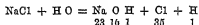
SCHEDULE SHOWING APPORTIONMENT OF MATERIAL COST VALUE  
TO EACH PRODUCT PER TON OF COAL

	Yield in Lbs of Recovered Products per Ton of Coal	Distribution of Waste to Recovered Products (Lbs.)	Revised Weight of Recovered Products	Material Cost of Each Product on Basis of Weight
Coke	1 320 0	69 47	1 399 47	\$2 78
Coal tar	120 0	6 32	126 32	25
Benzol	21 9	1 15	23 05	045
Sulphate of ammonia	26 0	1 37	27 37	055
Gas	412 1	21 69	433 79	87
Waste (water)	100 0			
Total	<u>2,000 0</u>	<u>100 00</u>	<u>2 000 00</u>	<u>\$4 00</u>

In conformity with the rules established above, Sheppard then shows the total production cost for each product manufactured. Selecting any one of these products (coal tar for example, the computation (assuming missing figures) would be as follows:

Material cost of 120 lbs (12 gals) as above	\$ 25
Proportionate part of operating expenses coke department	02
Materials and supplies	02
Salaries and wages	08
Repairs to machinery and equipment	02
Depreciation machinery and equipment	03
Proportionate part of plant overhead	03
Proportionate part of general overhead	03
Total cost	<u>\$ 48</u>
Sale price of 12 gals coal tar at 5 cents per gal	\$ 60
Less cost of 12 gals as computed above	48
Profit on 12 gals of coal tar	<u>\$ 12</u>

Another illustration is that of a joint cost distribution on the basis of atomic weights given by Thornton (Journal of Accountancy vol 51). It applies to the electrolytic soda-chlorine-hydrogen process. The chemical reaction represented by the process is



The figures under the symbols on the right hand side of the chemical equation represent atomic weights. Barring moisture and impurities, there are produced end products in the ratio of 40 pounds of caustic soda (NaOH), 35 pounds of chlorine, and 1 pound of hydrogen. The joint costs are thus allocated between the soda and chlorine on the basis of their atomic weights.

**ALLOCATION OF JOINT COSTS ON BASIS OF SELLING PRICES**—The most popular method of distributing joint costs is on the basis of the relative market values (i.e., selling prices) of the end products. As it works out in practice it is a weighted market value basis, since the market value of each product is the product of the weight or other quantity by the unit value. Under this method each product is charged for what the traffic will bear, since the higher the market value, the greater the cost charged against the product. On the other hand, fluctuations in the market value of any one or more of the end products automatically change the apportionment of the joint costs, though actually it costs no more to produce than before. As long as fluctuations in prices of the various products are synchronized (not necessarily in the amount but in the rate of change) their respective costs remain constant. But with some products fairly stable, and others fluctuating, the method breaks down.

Using the same example of lumber mill costs used for the average unit cost proration, the joint cost of \$53,000 is distributed to the various grades on the basis of their market values as follows:

## MARKET VALUE METHOD OF JOINT COST APPORTIONMENT

Grades	Quantity Produced (Ft.)	Market Value per 1,000 Ft.	Total Market Value	% of Total Market Value	Prorated Cost	Cost per 1,000 Ft.
First and seconds	250 000	\$105 00	\$ 26 250	17 65	\$ 9 354 50	\$37 42
No 1 common	1 250 000	70 00	87 500	53 82	31 174 50	24 94
No 2 common	500 000	40 00	20 000	13 45	7 128 50	14 26
No 3 common	500 000	30 00	15 000	10 08	5 342 40	10 68
	<u>2 500 000</u>		<u>\$148 750</u>	<u>100 00</u>	<u>\$53 000 00</u>	

The same result may be obtained by the method shown below. In this case the average cost of \$21.20 taken from the average cost method is distributed and used to find the cost per 1,000 feet.

## ALTERNATIVE COMPUTATION

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Grades	Quantity Produced (Ft.)	% Yield	Market Value per 1,000 Ft.	Yield in Dollars (3) × (4)	% of Dollar Yield	Prorated Cost (6) × \$21.20	Cost per 1,000 Ft. (7) - (3)
First and seconds	250 000	10	\$105	10 50	17 65	\$ 3 742	37 42
No 1 common	1 250 000	50	70	35 00	53 82	12 470	24 94
No 2 common	500 000	20	40	8 00	13 45	2 852	14 26
No 3 common	500 000	20	30	6 00	10 08	2 127	10 68
	<u>2 500 000</u>	<u>100</u>		<u>59 50</u>	<u>100 00</u>	<u>\$21 20</u>	

Another illustration of prorating joint costs, found in grading tobacco leaf, is shown below. It is based on a purchase of 1,000 pounds of ungraded leaf at a cost of \$270.

## PRORATING TOBACCO LEAF COSTS

(1)	(2)	(3)	(4)	(5)	(6)
Grade	Quantity (Lbs.)	Unit Market Value	Total Market Value	% of Total Cost to Total Market Value	Prorated Value
1	600	\$ 35	\$210 00	90*	\$189 00
2	200	25	50 00	90	45 00
3	200	20	40 00	90	36 00
	<u>1 000</u>		<u>\$300 00</u>		<u>\$270 00</u>

\*  $270 - 300 = 90\%$

Note that the arithmetical computation of the prorated cost differs from that used in previous examples. In these examples each figure in column 4 was expressed as a per cent of the column total and each per cent was applied to the joint cost to give the prorated costs. The alternative used above, computes the total joint cost as a per cent of the total market value, and applies that per cent to the individual market values. The results in both instances are the same.

A variation of this method is given by Green for the hog-packing industry (Fig. 15). This example illustrates the costing for pork products. The difference in accounting procedure between beef and hog packing is due to the fact that beef is sold in the form of dressed carcasses while hog operations result in various products such as hams.



shoulders etc Fig 15 shows that the end products are priced on the basis of their current market value The total values so obtained are subtracted from the total cost consisting of live cost plus expenses of slaughtering, etc The difference represents cutting profit or loss

In other words, the figure of \$12.72 represents the joint cost of the various products obtained But instead of apportioning the joint cost, the meat packer values the products at the market and by comparing the total market value with the joint cost finds a variance representing a so called cutting profit or loss

The "converted live cost" in Fig 15 is found by dividing the net live cost (\$12.10) by the yield of dressed carcass (89.5%). The same explanation holds for the figures for killing and dressing expense and for total cost However for 'value of cuts' the dressed value is given by the schedule and the value "per cwt alive" is to be found The latter (\$12.68) is obtained by multiplying the total market value (\$18.25) by the yield of dressed carcass (89.5%)

The process account for Hog Killing and Cutting is shown in Fig 16 (Packinghouse Accounting) In general the transfers to other processes are made at actual weights and at net market values

HOG CUTTING TEST—SHORT FORM			
Class	Butchers	Weight Average	220/240
Date	July 15 19—		
	Yield %	Per Cwt Alive	Per Cwt Dressed
Cost of live hogs		\$12.80	
Less value of by products		.64*	
Net live cost		\$12.16	
Yield of dressed carcass	89.5		
Converted live cost			\$17.80
Plus expense of killing and dressing		.55	.81
Total cost		\$12.72	\$18.31
Value of cuts (per schedule below)		12.68	18.25
Cutting margin (profit or loss)		—\$ .04	—\$ .06
Details of Cuts	% of Total Dressed Weight	Price per Lb	Value per Cwt
Ham skinned	17.2	\$ .24	\$ 4.18
Piccinis	8.0	20½¢	1.64
Boston butts	3.8	.25	1.45
Bellies square cut	15.8	17½¢	2.73
Fat backs	4.3	10½¢	.46
Loins blade-in	14.4	23½¢	3.33
Spare ribs	2.2	16½¢	.36
Plates and jowls	3.3	.10	.23
Trimnings	4.3	.18	.77
Lards (lard base)	21.8	.13	2.83
Feet tails, bones	2.9	.06	.17
Total carcass products	100.0		\$18.25

\* As per schedule based on standard yields and current market prices

FIG 15 Market Value Method of Joint Cost Apportionment

## HOG KILLING AND CUTTING DEPARTMENT ACCOUNT

CHARGES	CREDITS
1 Inventories on hand from last period	4 Transfer to Fresh Pork Cuts Department
2 Cost of hogs transferred from Live Hog account	5 Transfer to Pork Small Products Department
3 Labor supplies, and other expenses	6 Transfers to Sweet Pickle Department
	7 Transfers to Dry Salt Department
	8 Transfer to Barreled Pork Department
	9 Transfers to Frozen Pork Department
	10 Transfers to Frozen for Cure Department
	11 Transfers to Sausage Department
	12 Transfers to Animal Fertilizer Department
	13 Transfers to Casings Department
	14 Transfers to Hog Hair Department
	15 Transfers to Prime Steam Lard Tanks Department
	16 Transfers to Grease Tank Department
	17 Transfers to Condemned and Sterilized Loss account
	18 Inventories carried over to next period

(Balance is net gain or loss on slaughtering and cutting operations for period)

FIG 16 Departmental Operating Account

Fig 17 shows the application of the market value proration method for an oil refinery, as adapted from Tuttle (Petroleum News). Only the material value is prorated, labor and overhead being separately costed for each product.

**Prorating Total Costs to Grades**—A variant of the market value method is found in the glue industry, where the cost finding procedures are designed to spread the profit or loss against the value assigned to the several products, adjusting these so that in total they represent the total cost or outlay. The effect is simply to allocate the total costs incurred to the various products on the basis of an allocation similar to the market value method. A quantity of raw material of known cost is put into process. The products from the cooking operations are the several "runs of glue." The first run is of the highest grade, has the highest market value, and costs the least. Succeeding runs require higher temperatures, cost more, and produce lower grades of products. It is

JOINT PRODUCT COSTS IN THE OIL INDUSTRY

Product	(1) Yield in Gallons	(2) Realiza- tion per Gallon	(3) Total Realiza- tion (1) × (2)	(4) Per Cent of Total Realization	(5) Prorated Cost	COST PER GALLON		
						Material (5) - (1)	Labor and Overhead	Finished (6) + (7)
Gasoline	24.79	\$ 1.14	\$2.83	49.05	\$1.87	\$ .0754	\$ .010	\$ .0854
Benzine etc	2.00	.098	.20	3.47	.13	.0650	.010	.0750
Kerosene	9.96	.028	.28	4.85	.19	.0191	.010	.0291
Lubricating	4.47	.135	.60	10.40	.40	.0895	.035	.1245
Fuel oil	51.26	.032	1.64	28.42	1.08	.0211		.0211
Gas oil	3.00	.046	.14	2.43	.09	.0300	.003	.0330
Asphalt	1.93	.040	.08	1.33	.05	.0239	.005	.0309
Loss	2.59							
	100.00		\$5.77	100.00	\$3.81			

Fig 17 Allocation of Joint Cost on Market Value Basis

entirely impracticable to attempt to determine the actual money cost of each skimming and even if possible such figures are meaningless, for the effect is to show the lowest cost on the first grade of product and the highest cost on the lower grades, the last or poorest skimming having the largest cost. The procedure, therefore, is to determine the cost of all glue produced and spread this total cost over the various grades on the basis of their respective tests of purity. The method is illustrated below and is adapted from Bliss (Management Through Accounts)

#### COST FINDING IN THE GLUE INDUSTRY

Raw materials—sinews hide trimming etc (26 000 lbs at \$ 44¢ per cwt)		\$116 00
Manufacturing expenses		
On materials (260 cwt at \$1 20)	\$312 00	
On products (25 6 cwt at \$6 70)	171 52	483 52
Total outlay		\$509 52
Deduct by product credits		
Grease (1 300 lbs at \$ 05)	\$ 65 00	
Tankage (1 560 lbs at \$10 50 per ton)	8 19	73 19
Yield of glue (2 560 lbs or 9 85%) cost		<u>\$526 33</u>

This joint cost is prorated over various grades produced as follows

	(1) Yields Lbs	(2) Test	(3) Units (1) × (2)	(4) Cost per Cwt	(5) Cost per Cwt
1st run	250	90	22 500	\$ 65 50	\$28 60
2nd run	420	80	33 600	99 50	23 60
3rd run	840	70	58 800	174 00	20 80
4th run	1 080	60	63 000	186 33	17 15
Totals	<u>2 560</u>		<u>177 900</u>	<u>\$526 33</u>	

The test index is an indicator of the quality and therefore of the market value of each run or grade produced. Hence, multiplying the yield for each run by its test value is equivalent to multiplying it by the market value. The resulting figures when reduced to percentages of totals furnish the means for calculating the prorated costs. These are then reduced to a cost per cwt.

Gelatin manufacturing operations are very similar to those found in the glue business and the cost finding procedure recognizes the same principles. The figures below show the method used in determining the cost of the several grades of gelatin produced from one lot of raw material put into the process. The joint cost (\$55 40) is 96 23% of the total market value (\$57 57), therefore the cost of each grade is 96 23% of its respective market value. The unit cost is similarly found by applying the same percentage to each unit market value.

#### COSTING OF JOINT PRODUCTS IN THE GELATIN INDUSTRY

	Per Cent of Gelatin
Raw materials (100 lbs at \$4 yield 18 2% gelatin)	\$22 00
All expenses operating and selling	33 40
Total outlay	<u>\$55 40</u>

## Distribution of joint cost

	Grade	Unit Market Value	Total Market Value	Cost per Lb	Prorated Cost
62 0 lbs	AAA	\$ 65	\$40 30	\$ 6255	\$38 78
14 0 lbs	AA	50	7 00	4814	6 74
14 0 lbs	A	45	6 30	4330	6 06
9 5 lbs	AB	40	3 80	3849	3 66
5 lbs	AC	35	17	3368	16
Total value			<u>\$57 57</u>	Joint Cost	<u>\$55 40</u>

$$\$55.40 - \$57.57 = 96.23\%$$

The illustrations just given are evidence that the most practical method in most cases is that of combining the total cost of production of all grades obtained and then allocating this cost to the several grades in proportion to their relative values. This is admittedly an entirely arbitrary procedure, but with the facts what they are, any form of costing necessarily is arbitrary.

An illustration of the application of this method in a pea canning plant is given by Greer and Wilcox (Cost Accounting Problems). It is assumed in tabulation below that peas have been purchased on contract at a flat price, and that the processing operation is uniform for all grades. The peas after shelling are graded for size, and are canned in lots according to grade. From the total cost and the total estimated sales value it is possible to develop a cost per can for each grade which is proportionate to the selling price per can currently obtaining for that grade. The effect of course is to produce a uniform gross margin on the sales of each grade which is obtained as long as the selling prices remain in the same relation to one another as those used in the cost test.

(For application of standard costs to canning product yields, see discussion later in this Section.)

## STATEMENT OF OPERATIONS FOR ONE MONTH

	Total	Per Cwt
Cost of peas contract (43 000 lbs shelled)	\$1 290 00	\$ 3 00
Expenses receiving and handling		
Receiving stations	627 10	1 46
Trucking to cannery	136 80	32
Cost of peas at cannery	\$2 053 90	\$ 4 78
Expenses canning (per can, \$ 071)	2 442 40	5 68
Cost of peas in cans	<u>\$4 496 30</u>	<u>\$10 46</u>

## Distribution of joint cost to grades

Grade	Production (No Cans)	Sales Price per Can	Total Sales Value	Cost Allo- cated on Sell- ing Price	Cost per Can
1	6 880	\$ 20	\$1 376 00	\$1 164 09	\$ 169
2	13 760	16	2 201 60	1 802 55	135
3	12 040	13	1,565 20	1 324 15	110
4	1 720	10	172 00	145 61	85
Total	<u>34 400</u>		<u>\$5 314 80</u>	<u>\$4 496 30</u>	

**COST METHODS IN CRUDE OIL REFINING**—Crude oil when received at the refinery is treated in topping stills which through boiling and distillation break it up into gases gasoline kerosene fuel oil, lubricating oils, asphalt coke etc. Other processes depend upon the application of heat to produce changes in molecular structures for the purpose of securing the desired products. These processes include cracking re-forming polymerization hydrogenation, and catalytic reaction and are present in different combinations in individual refineries. According to Waters (N. A. C. A. Bulletin, vol. 24) total refinery operating costs fluctuate but little.

Operating labor maintenance supplies and depreciation (which is a very large cost) fluctuate practically not at all unless an entire unit is taken out of operation. Fuel for a modern refinery is at no cost. The majority of fuel used is gas from refining operations which if not used, goes into the air and is wasted.

However, fluctuation in yields of the various products obtained from a barrel of crude oil are chiefly responsible for cost fluctuations of these products. The same source cited above states that better yields will pay for a million dollar piece of equipment in from one to two years. The problem of distributing the joint production costs is therefore a difficult one. Waters states:

Cost accounting or distribution of exact cost to finished products is generally unsatisfactory unsolved and apparently impossible of complete solution. The nature of the raw material containing such a conglomeration and combination of products has defeated any and all attempts to distribute just and correct portions of its cost to the finished products.

He cites in his support an oil company executive:

We have no method of accurately computing the cost of each product manufactured from crude oil chiefly due to two facts: first because it is impossible to assign each product its just proportion of the cost of the raw material, the largest single item of cost, and secondly because the refining processes are continuous and there is such an interrelation between them as to make the allocation of the processing costs to individual products impossible without major arbitrary assumptions.

Nevertheless some attempt is generally made for costing the end products. Among the methods are various forms of joint product and by-product accounting.

**Average Unit Cost**—According to R. W. McKee (Handbook of Petroleum Accounting), the total raw material cost and processing expenses are divided by the total yield to arrive at a uniform cost per unit of product. By this method some joint products bear too high a cost, others too little. Crude oil is bought on the basis of product content, a better price being paid for high gasoline content. This first cost should be reflected proportionately in the end products, if possible.

**Weighted Selling Ratio Method**—According to the same source joint costs may be spread over the end products on the basis of their relative market values. This is done on the theory that the same rate of gross profit is earned on each. Daily gauge readings on all refinery tanks are taken at the end of each day and reported to the refinery production clerk. The latter prepares a summary of commodity move-

ments analyzed into consumption, production, and shipments. The refinery production report is then prepared, showing consumption, production, and losses in each process, and is forwarded to the accounting department. For accounting convenience each process is identified by a number, as follows:

Process No.	Nature of Process	Product Consumed	Product Produced
Process No. 1	Direct refining	Crude oil	Raw gasoline Fuel oil Stove oil Kerosene stock Kerosene Paints distillate
Process No. 2	Rerunning	Treated cracked distillate	
Process No. 3	Gasoline treating	Raw gasoline	Treated gasoline
Process No. 4	Kerosene treating	Kerosene stock	Kerosene
Process No. 5	Cracking	Stove oil	Raw cracked distillate Fuel oil
Process No. 6	Cracked distillate treating	Raw cracked distillate	Treated cracked distillate

To obtain the cost of production, the cost of the commodity consumed is first calculated. In the case of process No. 1, this is the raw material cost (crude oil) plus pipe line expense. For other processes, the cost of products is made up of the transferred cost of oils consumed, plus their share of refinery expenses of the process in which they are produced. A refinery expense ledger is kept to facilitate determination of process costs. These are made up of direct and distributed charges, the latter being apportioned on the basis of some physical coefficient. In the figures below, the crude oil cost is made up of:

- 1 Opening inventory at the cost carried over from a prior period
- 2 Purchased crude at actual cost according to invoices
- 3 Raw gasoline (being rerun) for convenience the previous month's rate is used for such transfers
- 4 Pipe line expense

#### CRUDE OIL FLOW

	Barrels	Gallons	Amount
Crude Oil Inventory			
Inventory July 1	15 013.39	630 502	\$20 045.01
Purchased	42 356.63	1 778 978	47 441.15
From raw gasoline	3 665.76	153 962	10 024.79
Pipe line expense			2,136.34
Total	61 035.78	2 563 502	
Less shortage	148.65	6 243	
To account for	60 887.13	2 557 259	\$79 647.29
Consumed Process No. 1	51 048.64	2 144 043	\$66 777.42
Inventory, July 31	9 838.49	413 216	12 869.87
Total accounted for	60 887.13	2 557 259	\$79 647.29

PROCESS COST LEDGER			REFINERY		PROCESS No. 1	
			SUMMARY FOR MONTH OF _____			
Commodity	Gallons			Total Costs	Price per Gallon	
Consumed Crude oil	2 144 043			\$68 777 42		
		Process Expenses				
		Labor	\$1,288 25			
		Fuel	98 88			
		Chemical Supplies and Expense	82 89			
		Repairs	28 06			
		Service Department and General Expense	1 996 46			
		Royalties				
		Total expenses		4 287 15		
		Total process cost		\$71 074 57	\$ 03315	
		Cost per gallon				
Produced						
		Price Realized + at Refinery	Total Realized Value	% of Total	Allocated Cost	
		\$ 11748	\$30 003 05	6° 46	\$44 303 18	\$ 0451872
	681 010	01948	18 857 29	14 74	10 476 39	0100352
	069 574	06177	6 260 73	4 59	3 475 55	0176396
	197 064	07183	12 651 35	9 83	7 622 17	0396895
	176 139	10937	4 734 30	3 70	2 625 79	1007517
	43 287	08640	5 554 40	4 33	3 077 53	0476717
	64 257					
	2 131 350		123 043 10	100 00	Total Allocated	
12 893				71 074 57		
2 144 043						
Raw gasoline						
Fuel oil						
Stove oil						
Kerosene stock						
Kerosene						
Distillate						
Total produced						
Process loss						

FIG 18 Refinery Process Cost Ledger



A cost statement for process No 1 is then prepared (Fig 18). The form is adapted from McKee (Handbook of Petroleum Accounting). The joint costs are prorated on the weighted selling ratio basis. The realized value, representing the known sales value less marketing and transportation expense is posted to the process cost ledger in the column headed "Price Realized at Refinery." Crude oil cost and process expenses are also posted to this ledger, and the resulting joint costs apportioned to the products obtained.

Journal vouchers are then prepared to credit Process No 1 and charge the product inventories at the refineries. They are posted by the general ledger bookkeeper to the control accounts, and returned to the cost division for detail ledger posting. This is necessary because the process accounts are segregated as to refineries and the inventory records are maintained for individual products at each plant. The same procedure is repeated with other processes.

When all transfers and cost calculations are completed, inventory schedules by products are prepared of which the following is a sample.

	Barrels	Gallons	Amount
Raw Gasoline Inventory			
Inventory July 1	951 09	39 971	\$ 2 551 41
Produced Process No 1	16 214 53	681 010	44 303 18
Produced Process No 2	2 317 20	97 326	4 154 12
To account for	<u>19 483 52</u>	<u>818 307</u>	<u>\$51 008 71</u>
Consumed Process No 3	11 774 17	494 515	\$30 573 98
To Crude Oil	3 665 76	153 962	10 024 79
Inventory July 31	<u>4 043 59</u>	<u>169 830</u>	<u>10 409 94</u>

A variation of the above method of cost allocation is given by Waters (N A C A Bulletin, vol 24) in which the joint costs are prorated on a "per barrel" basis (Fig 19). It is based on the following assumed figures:

Crude oil at refinery	\$1 4080
Refinery operating costs	2100
Joint cost	<u>\$1 7080</u>

To obtain the allocated cost multiply the yield per cent by the amount realized per barrel, this produces the sales value or total realization of each product in a barrel of crude. The latter is divided into the refining cost (cost of crude plus operating expense) resulting in a ratio of total refinery cost to total sales value. The ratio multiplied in turn by the sales value of each product then yields the allocated cost, which is finally reduced to a cost per barrel. Using the figures in the above table the following values are obtained for gasoline:

- 1 Sales value 52% × \$2 6350 = \$1 3702
- 2 Ratio of total cost to total sales value  $\$1 7080 \div \$1 3702 = 1.2465$
- 3 Allocated cost  $\$1 3702 \times 1.2465 = \$1 7080$
- 4 Cost per barrel  $\$1 7080 \div 52\% = \$3 2846$

YIELD	Per Cent Barrel Yielded	Realization Value per Barrel	Total Realization	Allocated Cost	Cost per Barrel
Gasoline	52%	\$2 6350	\$1 3702	\$1 2518	\$2 4073
Kerosene	7	2 1276	1489	1361	1 9443
No 2 fuel oil	9	1 7583	1582	1445	1 0056
Heavy fuel oil	21	9151	1022	1756	8362
Gas and loss	11				
	100%		\$1 8695	\$1 7080	

FIG 19 Joint Cost Apportionment on Realization Basis

	(1) Yield Per Cent	(2) Gravity	(3) Barrel Gravity Factor (1) × (2)	(4) Barrel Gravity Per Cent	(5) Allocated Cost	(6) Cost per Barrel
YIELD						
Gasoline	52%	52	2 704	74%	\$1 2639	\$2 4306
Kerosene	16	33	528	15	2562	1 6013
Heavy fuel oil	21	19	399	11	1879	8948
Gas and loss	11					
Totals	100%		3 631	100%	\$1 7080	

FIG 20 Barrel Gravity Method

	Barrel Gravity Per Cent	Allocated Crude Cost	Heat Units Per Cent	Allocated Refinery Operating Expense	Total Costs	Cost per Barrel
YIELD						
Gasoline	74%	\$1 1085	38%	\$ 0798	\$1 1883	\$2 2852
Kerosene and gas oil	15	2247	9	0189	2436	1 5225
Heavy fuel oil	11	1648	53	1113	2761	1 3148
Gas and loss						
Totals	100%	\$1 4980	100%	\$ 2100	\$1 7080	

FIG 21 Gravity Heat Units Method for Joint Cost Distribution

**Barrel Gravity Method**—It is a recognized fact that crude oil cost is dependent to a large extent on its content, the higher the gasoline content, the better the price paid for it. Some companies recognize this, and take it into account in apportioning the joint production costs. The technique is similar to the weighted selling ratio method, i.e., instead of using realized market values as a basis for the cost distribution, barrel gravity is substituted. Fig 20, adapted from Waters, cited above illustrates the procedure.

The barrel gravity method is obviously simple. It has been criticized, however, on the ground that the resulting prorated costs are not accurate because the correlation between the weighting factors and actual cost is not perfect, although according to Waters "there is some small degree of correlation between gravity and the commercial value of the products."

**Gravity Heat Unit Method**—Under this method only the crude oil costs are distributed on the basis of gravity content. To these costs are added the refinery operating expenses distributed on the basis of the heat units applied. The heat units are expressed as a per cent of the total heat units applied to obtain each product from the distillation process, as shown by records kept for that purpose. Waters shows the results in Fig 21, using the same basic data as above.

The same source expresses the belief that this method distributes the refinery costs satisfactorily, but the use of barrel gravity for distributing crude oil cost is open to the same objection as in the previous illustration in that it assumes that the gravity of each product manufactured bears a direct relation to the gravity of the raw material.

**By Product Method**—This method proceeds in the same manner as was explained under by-product accounting. The market value of by-

	Barrels	Value per Barrel	Total per Barrel
<b>BASIC COST OF GASOLINE</b>			
Cost of 100 barrels crude #1	100	\$1 4980	\$1 4980
Refinery operating expenses running for max amount gasoline (estimated)			2200
Total costs	100		\$1 7180
Deduct credit for 28 barrels heavy fuel oil at market	28	9151	2105
Gas and loss	14		
Net cost 63 barrels gasoline	63	\$2 3999	\$1 5075
<b>ACTUAL COST OF GASOLINE</b>			
Cost of one barrel crude plus refining expenses	100%	\$1 7090	\$1 7090
Yields			
Kerosene (see Schedule 1)	75%	\$1 7120	\$ 1198
#2 fuel oil (see Schedule 2)	9	1 5051	1355
Heavy fuel oil (see above)	21	9151	1922
Gas and loss	11		
Total value of by products	48%		\$ 4475
Value of Gasoline produced	52%	\$2 424	\$1 2605

FIG 22a Cost Allocation by Replacement Cost Method

## VALUE OF KEROSENE

(Schedule 1)

	Per Cent of One Barrel	Value per Barrel	Total
Kerosene produces			
Gasoline	75%	\$2 3020	\$1 7047
Residual fuel oil	15	9151	1373
Gas and loss	10		
Total	100%		\$1 9320
Deduct finishing costs			2900
Replacement value per barrel			\$1 7120

## VALUE OF No 2 FUEL OIL

(Schedule 2)

	Per Cent of One Barrel	Value per Barrel	Total
#2 Fuel Oil produces			
Gasoline	61%	\$2 3020	\$1 4567
Residual fuel oil	28	9151	2654
Gas and loss	10		
Total	100%		\$1 7261
Deduct finishing costs			2900
Replacement value per barrel			\$1 5061

FIG 22b Cost Allocation by Replacement Cost Method

products, such as kerosene, etc. is deducted from the crude oil cost including operating expenses. The resulting figure represents the cost of producing gasoline which is thus treated as the major product.

**Replacement Value Method**—This method is a combination of joint and by-product accounting. Gasoline is treated as the major product, and heavy fuel oil as the only by-product. The other products are valued at the cost of gasoline minus what it would cost to convert these products into gasoline. Two formulas are used and illustrated in Figs 22 and 23. They are both adapted from Waters (NACA Bulletin vol 24). Under the first of these (Fig 22) a basic gasoline cost is estimated and this figure together with the market value of heavy fuel oil is used to arrive at the replacement costs of kerosene and distillate (No 2) fuel oil. These costs when subtracted from the actual crude oil cost leave the value of the gasoline.

The second method determines the replacement values of kerosene and distillate fuel oil by the solution of algebraic equations which are formed on the assumption that the cost of gasoline from cracking kerosene or distillate fuel oil and crude oil must be the same. Thus the replacement value of kerosene is computed from the following equation based on facts concerning yields shown in Fig 22.

$$\frac{K - 15F}{75} = \frac{C - 23F}{63}$$

in which  $K$  = Replacement value of kerosene

$D$  = Replacement value of distillate fuel oil

$C$  = Delivered cost of crude oil (\$1 498 per barrel)

$F$  = Residual fuel oil realization (\$ 9151 per barrel)

Solving for  $K$

$$K = 1\,19048C - 12381F$$

$$= (1\,19048 \times \$1\,498) - (12381 \times \$9151)$$

$$= 1\,783339 - 113298$$

$$= \$1\,670041$$

Cracking expense

$$= 05$$

Cost of kerosene per barrel

$$= \underline{\underline{\$1\,720041}}$$

Similarly,  $D$  is computed from the following formula

$$\frac{D - 29F}{61} = \frac{C - 23F}{63}$$

$$D = 968254C + 667302F$$

$$= (968254 \times \$1\,498) + (667302 \times \$9151)$$

$$= \$1\,450444 + 601588$$

$$= \$1\,512032$$

Cracking expense

$$= 05$$

Cost of distillate fuel per barrel

$$= \underline{\underline{\$1\,562032}}$$

These figures are used in preparing the statement of the cost of production shown in Fig 23

	Per Cent of Barrel	Value per Barrel	Total
Cost of crude at refinery			\$1 4980
Operating expenses			2100
Total costs			\$1 7080
YIELDS			
Kerosene	7%	\$1 7200	\$ 1204
#2 fuel	6	1 5620	1406
Heavy fuel oil	91	9151	1922
Gas and loss	11		
Total value by products	48%		\$ 4032
Value of gasoline produced	52%	\$2 413	\$1 248

FIG 23 Cost Allocation by Replacement Cost Method  
(using algebraic formulas)

**Predetermined Estimate Method**—McKee (Handbook of Petroleum Accounting) mentions a simple method used by a number of American companies which is suitable where the gross profit each month need not be determined exactly. He describes it as follows:

It is based on the formula that the opening inventory plus expenses of manufacture and the cost of the raw materials purchased minus actual cost of sales for the period will equal the closing inventory. Instead of using accurately computed costs however, to arrive at cost of sales standard predetermined estimates are applied each month, and profits reported on this basis. Quarterly or semi annually the physical inventory is priced on

this same basis of predetermined costs. The cost of sales thus obtained and the closing inventory priced on the same basis are then added together and the total compared with the sum of opening inventory and purchases (including labor and expenses). The percentage of excess or deficiency of the former over the latter is applied to the closing inventory (still on an estimated basis) thus reducing or increasing it in the aggregate, to actual cost. This may be stated in algebraic form thus:

Let  $A$  = Opening inventory at actual cost

$B$  = Purchases, labor and expenses

$C$  = Cost of sales (on basis of predetermined costs)

$D$  = Closing inventory (on basis of predetermined costs)

$X$  = Closing inventory at actual cost

$$\text{Then } X = D \times \frac{(A + B)}{(C + D)}$$

### Standard Costs as Basis for Distribution

**STANDARD ALLOWABLE COSTS**—Under this cost procedure raw material costs are apportioned to products on the basis of predetermined standards. In joint-product industries the sales price is fixed in commodity markets and controlled by supply and demand, the problems of management center on purchasing and conversion rather than conversion and selling. Therefore the cost procedure adopted, to be of a maximum value, must provide management with the following information:

1. A convenient method for determining the price which can be paid for any given lot of raw material.
2. Means of measuring actual yields against those anticipated at the time of purchase of the raw material.
3. A comparison of actual conversion costs with those anticipated and used in establishing purchase prices.

According to Keller (N. A. C. A. Bulletin, vol. 21), these requirements have been met successfully by the operation of a standard cost system in a company whose problems closely parallel those of leaf tobacco companies. This concern's activities are confined to the purchase, preparation, and sale of a natural product. A year's supply of raw material is purchased either at public auctions or privately from many growers spread over a large geographical area. Thus material purchased in any one year varies as to quality, depending upon climatic conditions of the localities from which it is secured. The price paid for each lot is based upon the expected yield of grades as established by test sorting of representative portions before purchase. Material standards are used as a basis for calculating allowable purchase prices. For the purpose of illustration, it is assumed that the following rates have been established:

Purchase expense	\$ 50 per cwt
Conversion cost	
Labor	2 50
Factory burden	1 00
Total	<u>34 00</u>

Administrative and distribution cost  
Desired profit

20% of sales  
10% of sales

Forecast sales prices

Grade 1	\$200 00
2	100 00
3	50 00
4	30 00
5	20 00
6	10 00

With this information and an established allowance for scrap, the accountant is in a position to furnish the purchasing agent with a schedule of prices which can be paid for the various grades of raw material. This is calculated as shown in the following tabulation.

#### SCHEDULE OF ALLOWABLE PRICES

	GRADE					
	1	2	3	4	5	6
Forecast sales price	\$200 00	\$100 00	\$50 00	\$30 00	\$20 00	\$10 00
Less provision for profit and selling and administrative expenses	60 00	30 00	15 00	9 00	6 00	3 00
Balance	\$140 00	\$ 70 00	\$35 00	\$21 00	\$14 00	\$ 7 00
Available factory cost (10% loss)	126 00	63 00	31 50	19 00	12 60	6 30
Conversion cost and purchase expense	4 00	4 00	4 00	4 00	4 00	4 00
Price f o b factory which can be paid for raw material	<u>\$122 00</u>	<u>\$ 59 00</u>	<u>\$27 50</u>	<u>\$14 90</u>	<u>\$ 8 60</u>	<u>\$ 2 30</u>

**Standard Material Price**—The last line in the above table shows the maximum price that could be paid for a lot if it tested 100% grade 1 or 100% grade 2 etc. Assuming a given lot tests as shown below, the maximum price is \$15 72, which becomes standard for the lot.

#### ALLOWABLE PRICE FOR A SPECIFIC LOT

Grade	Per Cent	Allowable Grade Price	Value Factor
1	2%	\$122 00	\$ 2 44
2	6	59 00	3 44
3	12	27 50	3 30
4	25	14 80	3 70
5	25	8 60	2 15
6	30	2 30	69
	<u>100%</u>		
Standard price per cwt, f o b factory			<u>\$15 72</u>

The cost accountant receives a report of each lot purchased. Quantities on the report are priced at the standard price per hundredweight. A summary is then prepared of the standard values of all lots, and the total is adjusted for expected scrap loss. Total standard value is then allocated to grades as shown in the table below.



Grade	Expected Yield in Pounds	STANDARD VALUES BY GRADES			Material Cost per Cwt
		Forecast Sales Price per Cwt	Forecast Sales Values	Total Material Cost	
1	100 000	\$200 00	\$200 000 00	\$110 000 00	\$110 00
2	200 000	100 00	200 000 00	110 000 00	55 00
3	400 000	50 00	200 000 00	110 000 00	27 50
4	500 000	30 00	150 000 00	82 500 00	16 50
5	500 000	20 00	100 000 00	55 000 00	11 00
6	800 000	10 00	80 000 00	44 000 00	5 50
	<u>2 500 000</u>	<u>\$ 37 20</u>	<u>\$930 000 00*</u>	<u>\$511 500 00*</u>	<u>\$ 20 46</u>

\* \$511 500 - \$530 000 = 55%

Since the total actual material cost is 55% of the forecasted sales price, the joint material cost is distributed to the various grades by taking 55% of the expected sales price for each grade. Conversion costs (labor and overhead) are calculated at a uniform figure per hundred-weight for all grades. This yields costs for grades as shown below.

#### COSTS APPORTIONED TO GRADES

Grade	Material Cost	Conversion Cost (Labor and Burden with Allowance for Loss)		Selling and Ad- ministrative Expense	Total Cost
		Total Factory Cost			
1	\$110 00	\$3 89	\$113 89	\$40 00	\$153 89
2	55 00	3 89	58 89	20 00	78 89
3	27 50	3 89	31 39	10 00	41 39
4	16 50	3 89	20 39	6 00	26 39
5	11 00	3 89	14 89	4 00	18 89
6	5 50	3 89	9 39	2 00	11 39

**Measuring Efficiency**—With all standards set, the accountant is prepared to measure actual against expected yields for material, as well as for conversion costs. The latter are handled in the same way as in any other industry. The basis of material accounting is the inventory ledger card (Fig 24) a separate card being prepared for each lot. The card taken from Keller (NACA Bulletin, vol 21), shows the expected yield, the actual cost including standard buying expense and transportation charge, consumption of material, and inventory data.

**Material Price Variance**—From the inventory cards, material consumption (usage) is summarized by lots at the end of each cost period. The difference between the total actual and total standard values represents a price variance the responsibility for which falls on the purchasing department. The table below shows such a summary and reveals an unfavorable price variance of \$61 (i.e., \$3,488.20 - \$3,427.20).

Lot	Pounds	SUMMARY OF USAGES		
		Actual Value	Standard Rate	Standard Value
14 891J	1 100	\$ 126 50	\$12 69	\$ 139 59
17 101	5 000	600 00	11 58	679 00
22 233B	1 400	140 00	10 40	145 60
22 236D	10 800	1,350 00	12 10	1 300 80
30 111	6 400	921 60	14 00	896 00
30 112A	1 100	141 90	13 11	144 21
30 112B	1 500	208 20	14 40	216 00
	<u>27 300</u>	<u>\$3 488 20</u>	<u>\$12 55</u>	<u>\$3 427 20</u>

Lot Number 14 891 J Purchased from Brown and Grower Middleburg			Date Purchased 10/14/— Date Received 11/2/—		
EXPECTED YIELD		Per Cent	Pounds	Standard Rate per Cwt	Standard Value per Cwt
Grade					
1	2	200	\$122 00	\$ 244 00	
2	3	300	50 00	177 00	
3	10	1 000	27 50	275 00	
4	15	1 500	14 00	210 00	
5	30	3 000	8 00	240 00	
6	40	4 000	2 30	92 00	
		100	10 000	\$ 12 00	\$1 260 50
COST		10 000			
Purchase price			\$ 10 00	\$1 000 00	
Purchase expense			50	50 00	
Freight			1 00	100 00	
			\$ 11 50	\$1 150 00	
USAGE			INVENTORY		
Date	Pounds	Value	Date	Pounds	Value
10— Mar 3	500	\$ 126 50	10— Jan 1	10 000	\$1 150 00
11	400				
27	200				
31	Bal 8 900	1 028 50			
	10 000	\$1 150 00		10 000	\$1 150 00

FIG 24 Inventory Ledger Card

**Material Yield and Scrap Variances**—The same organization uses a weighted average price for clearing the Work in Process account, as shown below

## SCHEDULE OF MATERIAL CONSUMPTION

	Quantity	Unit Standard	Total Value
	Lbs	Value	
Inventory of Work in Process Mar 1	3 100	\$12 00	\$ 372 00
March charges (see preceding table)	27 300	12 55	3 427 20
Total charges to Work in Process	30 400	\$12 50	\$3 799 20
Less inventory of Work in Process Mar 31	2 200	12 50	275 00
March disappearance	28 200		\$3 524 20

The reported production for March was as follows

Grade	Quantity (Lbs)	Standard Rate	Material Values
1	540	\$110 00	\$ 594 00
2	1 220	55 00	671 00
3	2 420	27 50	665 50
4	4 400	16 50	726 00
5	7 240	11 00	796 40
6	10 120	5 50	556 60
	26 000	\$ 15 46	\$4 019 40

## STOCKS

	Quantity in Lbs	Rate	Amount	Quantity in Lbs	Rate	Amount
Actual cost	27 300		\$ 3 488.20	(1) March usage (actual)	27 300	\$ 3 488.20

## WORK IN PROCESS

3/1 Balance	2 100	\$12.00	\$ 252.00	March disappearance	2,200	\$12.50	\$ 275.00
(1) March usage	27 300	12.55	3 427.20	(2) Scrap	25 000		8 249.20*
	30 400		\$ 3 799.20	(3) Consumption	2 200	12.50	275.00
	2 200	12.50	\$ 275.00	3/31 Inventory	30 400		\$ 3 799.20
4/1 Balance							

\* \$3 524.20 — \$275

## SCRAP VARIANCE

(2) Actual scrap Gain on scrap	2 200	\$12.50	\$ 275.00	(4) Standard scrap allowance	2 200	\$12.50	\$ 275.00
			\$ 77.50				\$ 352.50
			\$ 352.50				\$ 352.50

## MATERIAL PRICE VARIANCE

(1) Loss (\$3 488.20 — \$3 427.20)		\$ 61.00					
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## YIELD VARIANCE

(4) Standard scrap allowance		\$ 352.50	(5) Standard value of production (see table)		\$ 4 019.40
(3) Consumed in production		2 249.20			
Gain or yield		417.70			\$ 4 019.40
		\$ 4 019.40			\$ 4 019.40

## FINISHED GOODS

(5) Standard production		\$ 4 019.40			
-------------------------	--	-------------	--	--	--

Fig 25 Standard Cost Accounts in Joint Costs

A scrap variance can now be calculated. Actual scrap is 2,200 pounds (i.e., 28,200 - 26,000) which is transferred from Work in Process to a Scrap Variance account. The latter account is credited for the standard scrap allowance (10% of 28,200 pounds), the balance representing in this case a gain or favorable variance, since less than standard allowed scrap was produced (Fig. 25).

The complete journal entries giving rise to the accounts in Fig. 25 are as follows:

## JOURNAL ENTRIES

(1)		
Work in Process	\$3 427 20	
Material Price Variance	61 00	
Stores		\$3 488 20
To record stores issues at actual and charge production at standard cost		
(2)		
Scrap Variance	275 00	
Work in Process		275 00
To transfer actual scrap out of work in process		
(3)		
Yield Variance	3 249 20	
Work in Process		3 249 20
To transfer actual production to yield variance		
(4)		
Yield Variance	352 50	
Scrap Variance		352 50
To credit latter account for standard scrap allowance		
10% of 28 200 lbs = 2 820 lbs		
28 20 × \$12 50 = \$352 50		
(5)		
Finished Goods	4 019 40	
Yield Variance		4 019 40
To clear latter account and charge finished goods for standard value		

**Sales and Profit Variances**—Sales for the month are priced at forecasted prices, and the total compared with actual sales income. The difference is a profit variance which is analyzed into a variance due to price changes and a variance due to volume changes. The latter is the responsibility of management, particularly of the sales department, and provides a check on that department's effectiveness.

**BASIC STANDARDS FOR GRADED PRODUCTS**—Many industrial processes using a raw material in bulk produce finished products of varying grades or quality and consequent variations in selling prices. Thus for example, in fruit canning, raw fruit is purchased in bulk but processed in a variety of ways and sold on the basis of established standards of quality yielding different prices. Peaches are packed in halves, sliced, whole, and diced, and each of these is packed in several sizes of containers, and again each in several grades. Similarly, leaf tobacco is purchased in bulk, graded for quality, the joint cost being apportioned over the entire lot in proportion to the respective selling values of the various grades. The same is true in the fur industry where skins are bought in bulk and then graded for quality.

**Apportioning Joint Costs**—Distribution of the joint cost of bulk material to be graded is made on the basis of the actual yield of the different grades obtained and then respective market values. As stated by Camman (Basic Standard Costs)

The entire cost is divided among the products actually derived at the point of grading according to their market values. The entire cost should include handling and processing charges incurred up to the stage at which the grades are determined as well as the original cost of purchase.

To accomplish this the same authority advocates the use of basic standard costs and the introduction of grade market differentials in setting the standards. In this way the actual costs are distributed on the basis of the standard costs of the products recovered, where the standards reflect the market values. The advantage of the scheme is pointed out by Camman:

Inasmuch as the basic standard costs are fixed this procedure has the advantage of apportioning the initial costs by a set differential so that should changes in the actual market values of the products occur disproportionately the consequence will be disclosed in the resulting profits rather than be hidden in costs distributed on the basis of the altered market values.

Fig. 26 illustrates the application of this principle to a lot consisting of 55 000 pounds: the joint cost to the point of grading was \$55 825 at an average standard cost per pound of \$1.015. The data in Fig. 26 are adapted from Camman. They may be explained as follows. Column 2 is obtained by applying the standard yield percentages to the total production. Column 3 figures represent actual yields as shown by production reports. Column 5 is the product of columns 2 and 4, column 6 is the product of columns 3 and 4 and shows what the standard should have been on the basis of the actual quantities obtained.

The total actual cost that is the joint cost is to be distributed on the basis of actual recovery. This is done by establishing a ratio between the total actual cost and the total standard cost for the actual yield, and then apportioning the costs to the grades on the basis of this ratio as follows:

The total of column 6 is \$51 600, the actual total cost is \$56 780, the ratio of actual to standard is 1.10. Therefore the computed actual cost for each grade in column 8 is obtained by multiplying each figure in column 6 by 1.10.

From this point on it is a simple matter to obtain variances by totals and by grades (Fig. 26).

**Yield Variance**—A yield variance arises because actual recovery of the end products is different from the standard expectation. Both the actual recovery and expected yields can be reduced to ratios or percentages. Based on Fig. 26 they are as follows:

Grade	Standard Expectancy	Yield Ratio
1	36.95%	66.7
2	49.26	85.5
3	13.79	186.4
	<u>100.00%</u>	<u>92.4</u>

Grade	(1) Standard Yield	(2) NUMER OF POUNDS		(4) Standard Rate per Pound	(5) Standard Quantity at Standard Rate	(6) Actual Quantity at Standard Rate	(7) Cost Ratio	(8) Joint Cost Dis- tribution	(9) COST VARIANCES		
		Standard Expect- ancies	Actual Yield						Over all (5)-(6)	Yield (6)-(7)	Price (7)-(8)
1	30%	16 500	11 000	\$1 25	\$9 625	\$13 750	110	\$15 130	+ \$5 500	+ \$6 875	- \$1 375
2	50	27 500	23 500	1 00	27 500	23 500	110	25 890	+ 1 610	+ 4 000	- 2 390
3	20	11 000	20 000	70	7 700	14 250	110	15 700	- 8 035	- 6 040	- 1 435
	100%	55 000	54 000	\$1 015	\$55 825	\$41 600	110	\$56 780	- \$ 985	- 4,225	- \$5 160

Fig 26 Joint Cost Distribution of Graded Products (on actual recovery basis)

The standard expectancy is found by expressing each figure in column 5 *Fig. 26* as a per cent of the total of that column. The yield is found by dividing the figures in column 6 by those in column 5. Camman, cited above, comments on the yield variance as follows:

If the grades had been present in the standard assortment the respective standard costs would have been in the percentages established in the basic standard costs. But it is found the standard costs of the existing grades are not in this percentage. The difference between the standard costs computed on the standard yield and on the actual yield is the extent of the yield variation at standard costs. The assortment affords considerably less of grades Nos. 1 and 2 with a consequent excess of grade No. 3. The yield ratios indicate this showing what percentage of the expected values was derived.

The aim of the manufacturer is, of course, to obtain as high a yield as possible, particularly in the more valuable grades. Even with uniform margins of profit on all grades, an increase in the yield ratio of the better grades results in a larger amount of profit.

**APPLICATION OF BASIC STANDARDS TO GRADED PRODUCTS**—The usefulness of basic standard costs in the solution of joint cost problems is clearly illustrated in the case of canneries. The chief accounting problem of canneries is the apportionment of the joint costs of raw material, labor and overhead. These are discussed by Barr (*N. A. C. A. Bulletin*, vol. 22). The raw product is purchased at a flat price per ton. This is a joint cost yielding different grades of finished pack. As stated by Barr:

The cost of the raw product cannot be charged at a uniform price per pound to the various grades for the reason that the selling prices on the lower grades are not high enough to return the average price per pound on the fruit used. Therefore the higher grades must be charged with enough more than the average price per pound to make up for the deficiency in the lower grades.

**Grade Differentials and Cost Elements**—To obtain variable fruit costs more or less arbitrary grade differentials are established whose effect is to weight raw material costs in such a way that the more expensive grades absorb a greater proportion of the joint cost. In effect this is a form of proration based on market values.

Distribution on the basis of sales value is not used because the selling price per pound of fruit varies for different grades and even for different sizes of the same grade. Prices for the same product often show large fluctuations over the years. Thus, over a quarter century prices of peaches have fluctuated from \$110 to \$350 per ton, and violent fluctuations appear even during a given year, or at least during the period in which a year's pack is sold. For these reasons the following grade differentials are used by one processor:

Fancy	130	Seconds	75
Choice	115	Water	70
Standard	100	Pic	50

In this way the cost of fruit is prorated over the entire pack so that the final fruit costs of Fancy bear 30% more cost than Standard, Choice, 15% more, etc. The differentials are applied to the cost of fruit delivered at the cannery, which thus includes

- 1 Price paid to grower
- 2 Freight and hauling charges
- 3 Buying and receiving expense
- 4 Cold storage if incurred
- 5 Expenses of lug boxes including losses from breakage and repairing and handling

Processing labor is excluded in making the cost distribution. This is at variance with the usual custom of prorating all joint costs at the separation or split-off point. As Bari says:

The net effect of this is that while the fruit itself and the receiving expenses bear grade differentials the preparation labor does not and is therefore charged to the various grades at a uniform price per pound.

Manufacturing overhead is allocated in proportion to total direct costs.

**Cost Records**—Three types of cost records are required:

- 1 An estimate of costs for the proposed pack for the coming season. This includes a determination of sizes and varieties to be packed, raw material requirements, labor scales, and all overhead items taking into account figures of prior years.
- 2 Daily cost reports for each variety of fruit or vegetable to show the efficiency of operations and point the way to avoidance of wastes and inefficiency.
- 3 Preparation of actual costs after the pack is over. These include pricing of the inventory and the preparation of profit and loss figures for each variety packed.

**Setting Raw Product Standards**—Raw material costs are prepared on a standard cost basis in advance of the season and take into account the quantity required, the price to be paid, and grade differentials.

Fig. 27 shows a hypothetical example of such a calculation. The percentages in column 2 are based on averages of several prior seasons. Column 3 figures represent grade differentials. Multiplying the figures in columns 2 and 3 together in effect translates the expected yields into equated yields on the basis of the standard grade. That is, 100 pounds of fruit assorted as shown in Fig. 27 are equal in value to 100.25 standard pounds of fruit.

RAW PRODUCT GRADE PRICE PER POUND

(1) Grades	(2) Expected Yield of Grades in Per Cent	(3) Relative Grade Price	(4) Product (2) × (3)	(5) Standard Grade Price per Pound
Fancy	10%	130	1300	\$ 04026
Choice	40	115	4600	03562
Standard	20	100	2000	03097
Second	15	75	1125	02323
Water	10	75	0750	02323
Pie	5	50	0250	01549
	100%		1 0025	

FIG. 27 Setting Raw Product Standards



By comparing the standard equivalent with the expected price for fruit, an average cost per standard pound of fruit is obtained. The following figures represent the assumed cost per ton:

Contract price to grower	\$50 00
Freight and hauling	4 00
Cold storage	3 85
Lug box expense	2 50
Buying expense	1 75
	<u>\$62 10</u>

Average cost per pound  $\$62.10 \div 2,000 = \$0.03105$

The total cost of \$62.10 represents the cost of an assortment of 2,000 pounds, which according to Fig. 27 is equal to 2,005 standard pounds (i.e.,  $2,000 \times 1.0025$ ). Thus the cost per standard pound of fruit is

$$\$62.10 \div 2,005 = \$0.03097$$

To find the standard grade price per pound for each grade, multiply the above unit cost by the grade differentials. The results are shown in column 5 of Fig. 27. Finally the standard raw product cost per case is obtained by grades and sizes as shown in Fig. 28.

Size	Grade	Pounds of Raw Product per Case	Grade Price per Pound	Cost per Case
2½	Fancy	40	\$04026	\$1 610
	Choice	40	03562	1 425
	Standard	40	03097	1 239
	Second	40	02323	929
	Water	40	02323	929
10	Fancy	36	04026	1 449
	Choice	36	03562	1 232
	Standard	36	03097	1 115
	Water	36	02323	836
	Pie	58	01549	898

FIG. 28 Standard Cost per Case

**Other Direct Costs**—The major material items are sugar and cans. Minor items are salt, spices, peeling compounds, and water. To these must be added labor, also rental and royalty on labor-saving machinery, and finally fuel and power. These are all reduced to standard costs per case and are shown in summary form in Fig. 29.

**\*Cost and Variance Reports**—Total standard costs are calculated for each day's pack and are illustrated in Fig. 30, covering costs for fruit, sugar, rent and royalty, and cans. In the same way labor costs by grades, sizes, and processes are computed. The unit costs are in all cases obtained from the tables showing the standard fruit cost per case and the direct manufacturing charges (Figs. 28 and 29). Comparisons

Size 2½	Fancy	Choice	Standard	Second	Water
Raw product	\$1 610	\$1 425	\$1 239	\$ 929	\$ 929
Cans	724	724	724	724	724
Sugar	490	330	195	070	
Rental and royalty	060	060	060	060	060
Labor	350	350	350	350	350
Total direct	\$3 234	\$2 889	\$2 568	\$2 133	\$2 063

Size 10	Fancy	Choice	Standard	Pie
Raw product	\$1 449	\$1 282	\$1 115	\$ 898
Cans	302	302	302	302
Sugar	445	305	175	
Rental and royalty	054	054	054	086
Labor	320	320	320	253
Total direct	\$2 570	\$2 263	\$1 966	\$1 539

FIG 29 Summary of Total Direct Manufacturing Costs

are made daily of actual with standard costs. The variance in raw product costs may be due to any one or all of three factors:

1. Use of more or less pounds of fruit per case than standard, i.e., usage variance, often called the fruit yield.
2. Variance in price per pound, i.e., price variance.
3. Higher or lower yield per case, i.e., a yield variance, this is commonly referred to as the grade yield.

The basic figures for obtaining variances are assembled in Fig. 31. In each case the actual quantity or cost is divided by the standard quantity or cost to yield a ratio which forms the basis for the variance calculations. The yield variance is important and is explained by Barr (N.A.C.A. Bulletin, vol. 22).

The value of the fancy grade per pound is 130 compared with only 50 for pie. This means that a pound of fruit packed into fancy grade is worth 2.6 times as much as a pound of fruit packed into pie and that this arises from the added selling value. Therefore, to pack into pie grade fruit that is suitable for fancy grade has just as serious an effect on the profits for the pack as using twice as much fruit as is necessary. A high cost of raw product per case cannot be corrected without a knowledge of whether the high cost is due to too much raw product being used or failure to realize high enough grades.

To calculate the grade yield variance it is necessary first to obtain a yield ratio. The latter may be obtained in two ways:

1. In Fig. 33, divide the total of column 7 by total of column 5  

$$\$2,113 - \$2,372 = \underline{\underline{8908}}$$
2. From the relationship existing among the ratios. Since but one ratio is unknown it may easily be found.

Over all ratio = Usage × Price × Yield ratios

$$8853 = 1.0287 \times 9662 \times ?$$

$$\text{Therefore Yield ratio} = \frac{\text{Over all}}{\text{Usage} \times \text{Price}} = \frac{8853}{1.0287 \times 9662} = \underline{\underline{8908}}$$

Size	Grade	No of Cases Packed	Weight (Lbs.)	RAW PRODUCT		SUGAR		CANS		RENTAL AND ROLATY	
				Per Case	Total	Per Case	Total	Per Case	Total	Per Case	Total
2½	Fancy	300	12 000	\$1 610	\$ 483	\$ 490	\$147				
	Choice	1 030	42 000	1 425	1 496	330	347				
	Standard	175	7 000	1,238	217	195	34				
	Total	1 025	61 000		\$3 196		\$528	\$ 724	\$1 104	\$ 06	\$ 92
10	Fancy	75	2 700	\$1 449	\$ 109	\$ 445	\$ 33			\$ 054	\$ 4
	Pe	75	4 350	898	67			\$ 302	\$ 45	030	6
	Total	150	7 050		\$ 176						\$ 10
		1 675	68 050		\$3 372		\$561		\$1 149		\$102

FIG 30 Standard Cost of Day's Production (exclusive of labor)

	Standard	Actual	Ratio	Variances	
				Unfavorable	Favorable
				1 950 lbs	
1 Weight of raw product (lbs)	68 050	70 000	1 0287		
2 Average cost of raw product per lb	\$ 03105	\$ 03	1 9662		
3 Weight of sugar (lbs)	11 220	12 000	1 0695		
4 Cost of sugar per lb	\$ 05	\$ 051	1 0200		\$272
5 Cost of raw product	\$ 2 372	\$ 2 100	8853	\$ 51	
6 Cost of sugar	561	612	1 0909		
7 Cost of cans	1 149	1 149	1 0000		
8 Rental and royalty	102	105	1 0294	3	
9 Cost of labor					
Preparation	220	300	1 3650	80	
Canning	223	245	1 0974	22	3
Cooking	83	80	9639		1
Stacking	51	50	9860		
	\$ 4 761	\$ 4 641		\$156	\$276
Less unfavorable variance					156
Net favorable variance					\$120

Fig 31 Costs and Variance Ratios

This yield ratio may be translated into a dollar variance as shown below

**Raw Product Variances**—On the basis of the data in Fig 31 and the yield ratio computed above the raw material ratios and variances are established (Fig 32). To compute the variances in Fig 32 by the ratio method it is first necessary to obtain the difference between the ratio as shown in the ratio column and 100%. The next column then shows how the variance is converted into a dollar equivalent. A different method for obtaining the variances which serves at the same time as a basis for allocation of the joint costs is shown in Fig 33.

The column headings in Fig 33 show how the data in each column are compiled. The method is somewhat different from that described by Camman (see comments below). The variances are obtained by simple column subtraction and are explained in Fig 32. There is little to be gained in this case by working out the different variances for individual grades. This is because as many as five varieties of fruit may be packed in one day, put up in different ways, sizes and grades. To carry out the calculations in detail for a normal pack might prove more burdensome than the results would warrant. But it is very significant as to any variety of fruit to know whether the cost is up or down by reason of more tons used than the standard or less, or the variation resulting from the price paid for the raw fruit or more or less net value in grade yields resulting from getting more or less of the higher grades.

The grade yield variance may be further explained as follows:

Fig 33 shows that the standard weight of the day's pack, 68,050 pounds if distributed according to standard expectation, would yield grade quantities and values according to columns 6 and 7. But it really yielded quantities and values as shown in columns 4 and 5. Since the total number of pounds is the same in both cases, any difference in value is due to a shift in the assortment of grades obtained. Hence the difference between columns 6 and 7 represents the grade yield variance.

The same result may be obtained by comparing the unit costs:

Standard cost per pound	\$ 03105
Average cost on basis of yield obtained (\$2 372 ÷ 68,050)	03486
Difference due to shift in yield	<u>\$ 00381</u>
Yield variance (68 050 × \$ 00381)	<u>\$259 00</u>

**Variations in Technique**—The technique of cost application for canneries presented above is criticized by Camman on two grounds:

1. The base against which variances are computed.
2. The kind of variances obtained.

According to Camman, the variances are computed against a hypothetical base. A distinction must be drawn between variations in the material costs of **graded products** and those which may be encountered in the production of **joint products**, in the latter case there usually is a scientific or rational basis for distinguishing between the known or reasonably determinable yield which may be obtained from the raw material and the actual yield which is obtained from the conversion process. In the case of fruit which may be assorted into several grades,

	Ratio	VARIANCE CALCULATIONS		Amount
		Based on Ratios	Based on Fig. 33	
Usage variance or fruit yield	1.0257	$0257 \times 68,030 \times \$ 03105$	Col (7) — Col (9)	— \$ 61.00
Price variance	9662	$0335 \times 70,000 \times 03105$	Col (9) — Col (11)	74.00
Yield variance	8908	$1092 \times \$ 2.372$	Col (5) — Col (7)	+ 259.00
Over all variance	8833	$1147 \times 2.342$	Col (5) — Col (11)	+ \$272.00

Fig. 32 Variance Calculations

(1) Grade	(2) Standard Expected Yield %	(3) Standard Grade Price per Lb	(4) SALABLE YIELD OBTAINED		(5) STANDARD YIELD EXPECTED		(6) Quantity in Lbs (2)×68.04	(7) Standard Value (3)×(6)	(8) ACTUAL QUANTITY AT STANDARD COST		(10) Ratio (11)÷(9)	(11) Joint Cost Dis- tribution (9)×(10)
			Quantity in Lbs (Fig. 30)	Value (3)×(4)	Quantity in Lbs	Value (3)×(8)						
Fancy	10%	\$ 64026	14 700	\$ 50 <sup>a</sup>	6 805	\$274	7 000	\$932	8833	\$ 324		
Choice	40	03562	42 000	1 466	27 220	970	28 000	997	8833	1 824		
Standard	20	03097	7 000	217	13 010	421	14 000	434	8866	192		
Seconds	15	02323			10 207.50	237	10 500	244				
Water	10	02223			6 805	158	7 000	163				
P <sub>10</sub>	5	01549	4 250	67	3 409.50	53	3 500	54	9518	80		
Totals	100%		68 050	\$2 372	68 050	\$2 113	70 000	\$2 174	8853	\$2 100		

Fig. 33 Apportionment of Costs to Grades

there is no scientific formula which can be applied to measure the content of any particular lot as between grades. The only measure which can be used is a hypothetical one such as an average over a period of time, this is the method employed by the cannery in question. As a consequence the variations are computed against a hypothetical base, and hence are themselves hypothetical. In the case of joint products, such as from milling or the mining of certain ores it is possible to determine by chemical analysis or in other ways what the standard yield for a given lot should be and thereafter to compute the variance in the actual yield from the standard.

Concerning the variances obtained, Camman also maintains that a usage variance or fruit yield in this case is entirely empirical; that in graded products there are only two material cost variances, namely, a yield variance as between grades and a price variance. Nevertheless, it would appear that a usage variance is in order in some form. Canneries continually overfill their cans because the net weight of fruit must be stated on the label and to play safe the cans are overfilled. This has led some canneries to establish a "fill" allowance which ultimately yields a "fill" variance, through these the extent of overfilling of cans can be controlled. Such a "fill" variance is, of course, a form of usage variance. In the cannery described above the price variance on this revised basis would be the same as before but the yield variance would represent the difference between the total or over all variance and the price variance.

Over all variance	8272 00
Price variance	74 00
Grade yield variance	<u>8198 00</u>

**BASIC STANDARDS FOR JOINT PRODUCTS**—Camman (Basic Standard Costs) draws a distinction between graded products and joint products on the ground that precise standards of yield may be established in the case of joint products, no such precision existing in the case of graded products. The distribution of the joint cost is made on the basis of the market value of the products to be recovered and the subsequent processing costs. In setting the standards two more factors, however, must be considered:

- 1 Yield variations
- 2 Content of the products in the original material

Thus Camman distinguishes between two types of yield variances: those due to changes in the content of the original material and those resulting from gains or losses in processing. The latter are of course, usage or effectiveness variances. Thus, in order to obtain proper yield variances it is necessary by testing, sampling, chemical analysis or by any other means to ascertain the composition of the raw material.

By incorporating the composition of the raw material in the basic standard, variations which might arise from the composition of the material are automatically eliminated, and any yield variation shown must therefore result from processing activities. Thus, the basic standard includes:

- 1 The formula in which the products should be recovered
- 2 Market differential
- 3 Subsequent recovery costs

(1)	(2)	(3) VALUES PER UNIT			(6)	(7)	(8)	(9)	(10)
		Market	Recovery Cost	Recovery (3) — (4)					
Product	Unit				Standard Yield	Net Recovery (5) X (6)	Yield Per Cent	For Stand- and Yield (1.75 X Col. 8)	Per Unit (9) — (6)
A	Net ton	\$3.21		\$3.2100	87 N T	\$2.15	34.40%	\$1.634	\$ 2.4400
B	M cu ft	.50	\$ 1429	3571	7 M cu ft	2.50	40.00	1.90	2714
C	Gal	.05	6050	04.50	12 gal	54	8.64	41	0342
D	Lbs	.025	0035	0215	26 lbs	56	8.96	426	\$32.7600
E	Gal	.20	0334	1666	3 gal	50	8.00	38	1247
						\$6.25	100.00%	\$4.75	

FIG 34 Setting Basic Standards for Joint Products

(1) Product	(2) Actual Recovery	(3) Standard Yield Per Cent (Fig. 34)	(4) Standard Cost Per Unit (Fig. 34)	(5) Standard Yield at Standard Cost \$51.600 × (3)	(6) Actual Yield at Standard Cost (2) × (4)	(7) Actual Cost on Standard Yield \$50.750 × (3)	(8) Variances		(10) Price (8) - (7)
							Over-All (5) - (7)	Yield (6) - (8)	
A	6.930 net ton	34.40%	\$ 2.4400	\$17.751	\$16.902	\$19.532	-\$1.781	+\$ .849	-\$2.630
B	70.150 M cu ft	40.00	2714	20.640	19.039	23.712	- 2.072	+ 1.601	- 3.673
C	136.323 gal	8.64	0342	4.458	4.630	4.903	- 445	- 177	- 271
D	232.407 lbs	8.96	32.7600	4.623	4.626	5.098	- 465	- 124	- 462
E	33.559 gal	8.00	12.6700	4.125	4.252	4.542	- 414	- 124	- 290
		100.00%		\$51.600	\$49.454	\$56.790	-\$3.180	+\$2.146	-\$7.326

FIG 35 Distribution of Joint Costs and Variances



Fig 34, illustrating the procedure, is adapted from Camman (Basic Standard Costs) It is based on the following assumed facts

Material X 1 gross ton	\$3 75
Initial processing cost	1 00
Joint cost	<u>\$4 75</u>

The figures in column 9 represent the allocation of the joint cost on the basis of the standard yields from a gross ton The last column expresses the standard costs in terms of the unit employed for measuring each product The distribution of the total costs based on standard yield may then be made as shown in Fig 35, adapted from Camman

Note that the apportionment of the actual cost (column 7 of Fig 35) is on the basis of the standard yield percentages The dollar variances are obtained directly in totals and for each joint product

If it is desired to express the results as ratios, this can easily be done

Over all ratio (\$56 780—\$51 600)	110 0
Price ratio (\$56 780—\$49 454)	114 8
Yield ratio (110—114 8, or \$49 454—\$51 600)	96 0

These ratios can then be used to distribute the variances to the joint products by taking the difference between the ratio and 100% and then multiplying by the appropriate base

# SECTION 11

## ESTIMATED COSTS

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## SECTION 11

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### ESTIMATED COSTS

#### Definitions

**METHODS OF COST DETERMINATION**—Costs of manufactured products or services may be determined through the use of

- 1 Continuous cost records
- 2 Cost approximations
  - a Cost finding
  - b Cost estimating

Continuous cost records represent a formal cost accounting procedure and constitute part of the **double-entry system**. They incorporate systematic routines which through the use of **subsidiary ledgers** subclassify costs in any desired degree of detail. Such ledgers are maintained as an integral part of the accounting system, "tied in" with controlling accounts in the general ledger or the factory ledger. In this framework the process of cost analysis is carried on as an intrinsic part of the regular accounting routine on a day to day basis. Formal accounting procedures also embrace a full application of **perpetual inventory** practices applied to raw materials, goods in process, and finished goods.

These records serve to identify parts of the total costs of operations with individual departments, technical processes, classes or specific lots of product. A cost accounting system may be designed to record sub-classifications of cost with respect to any individual operating center or other activity of the business.

**COST APPROXIMATIONS**—The main disadvantage of formal cost accounting is its expense. A considerable saving in accounting costs can often be effected by substituting occasional test checks of product costs for continuous and repetitive calculation of unit costs. This sort of cost analysis limits accounting activities to the accumulation of departmental figures for budget comparisons, and leaves unit product costs to be established at intervals by informal methods. This means that costs of operating particular processes or departments, or costs of producing specific lots of product, must be found by applying special calculations to existing data. Although the techniques employed in tracing costs in such circumstances are based upon principles similar to those applied in formal cost accounting, the results are less accurate.

**Cost Finding**—Cost finding may be defined as *ex post facto* determination of the cost of producing goods or performing services by the use

of informal procedures i.e. without carrying on the regular processes of cost accounting on a continuous or formal basis. The distinction between cost finding and cost accounting is not always an easy one to make. Product costs can be calculated without carrying on all formal procedures inherent in the cost accounting process. However, when formal techniques of subsidiary ledger classification and perpetual inventory control are abridged, or whenever cost analysis is carried on in a noncontinuous or nonrepetitive fashion, the resulting cost calculations are referred to as cost finding rather than as cost accounting.

**Cost Estimating**—Cost estimating represents the process of compiling the cost of articles to be made where experience supplies no complete figures. In compiling the estimated cost, use may be made of actual cost figures past or present, and of facts concerning the available plant and equipment, labor and burden rates, present and future market prices of material, knowledge of the processes to be performed, and good judgment applied to all these.

Another definition is given by White (N.A.C.A. Bulletin, vol 19)

A sound estimate is an exact representation of the lowest average cost that can be maintained in actual production.

A somewhat different viewpoint is maintained by Nevins (N.A.C.A. Bulletin, vol 16)

No system will ever guarantee that an estimate is the figure at which an article can or will be made. The only guarantee will be a scientific approach to the matter. Strict accuracy of course will not always be obtained but the more accurate the details of the estimate, the more accurate will be the total.

**ESTIMATING COST SYSTEMS**—Estimating cost systems represent a formal type of costing procedure and as such are discussed later in this Section. Such systems are based on cost estimates for material, labor and overhead. According to Amidon and Lang (Essentials of Cost Accounting),

Where the estimates are incorporated in the books and the books themselves are made to show differences between actual and estimated costs cost accounting of the estimated cost type is said to exist.

**COMPARATIVE RELATIONSHIPS**—Cost estimating deals with expected or probable costs to be incurred in the fabrication of products, construction of buildings or equipment, or rendering of services. Cost estimates are therefore prospective costs.

Cost finding and cost accounting deal with the analysis and interpretation of already extant data, concerning transactions or activities which have actually occurred. Cost estimating, per contra, is anticipatory in point of view, a cost estimate is an attempt to forecast what costs will be incurred if a prospective venture is carried out. Hence, although the line of demarcation between cost accounting and cost finding is indefinite, cost estimating is clearly differentiated by a forecasting rather than an interpretative aim. As expressed by Williams (N.A.C.A. Year Book, 1939)

Estimating is counting the cost before the money is spent and no matter what we may call them most modern cost systems are predicated on doing just this

The processes of cost finding and cost estimating do not differ materially hence the technique of cost finding is not separately discussed in this Section. Cost estimating however, has a function beyond the necessity of predicting a cost. Often cost estimates become adjuncts to job order or process costs, particularly if these are based on historical costs. In this way, cost estimates provide bases of comparison that are otherwise lacking in historical cost systems

### Nature of Costs to be Estimated

**COST CLASSIFICATIONS**—Cost estimating, especially in a large plant, is usually performed by specially trained personnel called estimators. They must possess on the technical side a thorough knowledge of the engineering basis of the product whose cost is to be estimated. This involves a knowledge of the kinds and quantities of material required in its manufacture, labor operations, tool costs, machine requirements, etc. On the accounting side the estimator must be thoroughly familiar with the official account classifications, with the nature and behavior of the expense accounts, and the bases upon which the joint expenses are

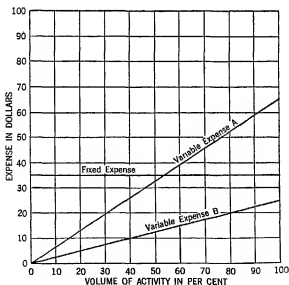


FIG 1a Types of Cost Behavior (Fixed and Variable Expenses)

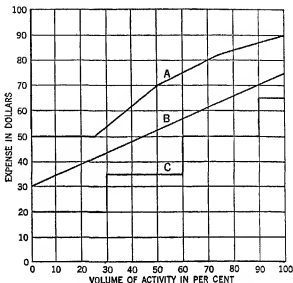


Fig 1b Types of Cost Behavior (Semi Variable Expenses)

apportioned. The latter represent expenses which, because they apply to group services, must be prorated or apportioned in order to identify them with a particular product or service. Such apportionment may be made on the basis of

- 1 Physical identification
- 2 Benefit derived
- 3 Facilities provided, etc

**COST BEHAVIOR FIXED AND VARIABLE COSTS**—Different costs respond differently to changes in volume. The estimator must know the behavior of elements entering into the cost of the product being estimated. Few costs are either 100% variable or 100% fixed. As stated by Freeman (NACA Year Book, 1939):

The real distinction in overhead costs is not so much between variable and fixed as it is between quickly moving and lagging. While the variable costs slide up and down on an inclined plane or ramp, the so-called fixed costs move up a step at a time and do not slide back so easily.

Schlatter (Advanced Cost Accounting) points out that particular items of variable cost may exhibit curved as well as simple linear patterns and calls attention to **semi-fixed costs**, which remain fixed over narrow ranges of activity, but which rise or fall abruptly to successively new levels over wider ranges. An example of this type of cost behavior is supervision, in the form of foremen's salaries. One foreman can oversee the work of 8, 10, perhaps 15 workers, but at some point, the task gets

out of hand and an assistant foreman is necessary. Fig. 1 indicates graphically various types of cost behavior.

**Seasonal Charges**—Certain operating charges exhibit seasonal patterns, i.e. the amounts tend to fluctuate because of differences in temperature, humidity, duration of daylight, etc., over the year. Thus heating costs are heavy in the winter months, and nothing at all in summer. Lighting, air-conditioning, buildings and grounds maintenance, and other items may show this sort of variation.

**Irregular Charges**—The most difficult type of operating charge to deal with from the point of view of product costs is the irregular or erratic type of costs, because these have a way of showing themselves at irregular intervals and in varying amounts. Many accountants charge items of this kind to current operations, thus distorting monthly product cost comparisons. Others meet the problem by setting up regular contingency or operating reserves which stabilize the monthly charges. Each month Profit and Loss is debited for the estimated amount of the charge, and an indicated reserve is credited. Actual expenditures are charged against the reserve. Examples of such items are found in many kinds of repairs, water bills, etc. The following entries illustrate the procedure.

(1)	
Manufacturing Expense	\$150 00
(Subaccount: Extraordinary Machine Repairs)	
Reserve for Extraordinary Machine Repairs	\$150 00
To set up reserve by monthly charges to operations	
(2)	
Reserve for Extraordinary Machine Repairs	110 00
Vouchers Payable	110 00
To charge actual expense incurred against reserve	

**NORMAL COSTS**—The practical answer by the cost accountant to the problem of stabilizing costs and incidentally income, is use of the normal cost concept.

Assume total production cost of 8 000 units of product in one department to be summarized as follows:

Direct Labor	\$ 8 800
Direct Materials	9 600
Variable Manufacturing Overhead	5 600
Total Variable Costs	\$24 000
Fixed Manufacturing Overhead	8 000
Total Costs	<u>\$32 000</u>

The actual cost per unit of product is \$4.00, but if the department had produced only 7 000 units the variable costs would have been \$21 000, total costs would have been \$29 000 and unit cost \$4.1428+. An inventory of 1 000 units of this product would thus be costed at \$4.000 in first case and \$4.143 in the second.

If facilities are adequate for the production of 8 000 units per year, only  $\frac{2}{3}$  of the fixed costs represent cost of product and  $\frac{1}{3}$  is an idle capacity cost, i.e. a cost of maintaining facilities which were not employed. If this is recognized the normal cost of 7 000 units of product is \$28 000 or \$4.00 per unit.



**Measurement of Idle Capacity Costs**—From an engineering point of view, practical considerations make it undesirable to define capacity in terms of maximum output. Some factor of safety, or margin must be allowed to take care of emergencies, it is never safe practice to operate equipment at maximum rates of speed for extended periods. From an economic point of view (and this is also included in the engineers calculations) capacity is an **optimum** rather than a maximum concept. As the intensiveness of use of any resource is increased, there is some point at which diminishing returns become evident, some level beyond which average unit costs become higher rather than lower with increased exploitation. As a practical matter, few plants ever operate at optimum output levels. Some amount of capacity is left as a matter of prudence for peak loads, extra business, or a margin to insure deliveries in case of partial breakdowns or other emergencies. Hence the normal or expected average rate of output is more significant for measuring idle capacity costs than either optimum or maximum level. (See Section 20 on Overhead and Normal Capacity.)

## Cost Estimating Factors and Procedures

**PURPOSE OF ESTIMATING**—Cost estimating technique represents a body of accepted practices and methods for estimating the cost of mechanical products. Concerning this point, Williams (N.A.C.A. Year Book, 1939) states:

The cost estimate properly prepared and intelligently used forms the basis for many decisions as to policy and business conduct and in many cases can be made to supplement, and even replace other procedures for collecting and controlling costs.

Decisions as to policy may be stated to include:

1. Advisability of embarking upon a program of manufacture or distribution. Thus in the case of an electric locomotive the cost must be determined in advance to see if the project is economically sound from the standpoint of economical operation and of manufacture.
2. Costs of alternate designs or methods including the possibility of cost reductions.
3. Setting a bogey against which subsequent expenditures may be measured.
4. Bidding or price setting where there is no established price structure. The products in question are made to a customer's design, specifications, and volume requirements.
5. Decision to make or to buy.

These five points represent the purposes or objectives of cost estimating. Of these the first, second, and fifth have to do with estimating the costs of manufacturing. The third is a matter of establishing estimating standards discussed later in this Section. Hence, the discussion below is confined to items 4 and 5.

**Setting Sales Prices**—Before sales prices can be quoted to prospective customers, it is necessary that a manufacturer have some knowledge of actual or estimated costs of merchandise on which he is quoting prices.

Without going into the subject of economics, it might be stated briefly that the seller must consider in setting sales prices, the present market prices of articles quoted on, the market price of similar articles performing the same functions or similar functions, the estimated cost price of the article, and the amount of profit necessary to pay for the time and money invested in the business. When a concern is making and selling a great many different kinds of articles, the problem does not change but it does become more complex and calculations are more difficult.

It may be good and profitable business to make and sell an article for a very small profit to make use of unused facilities or to obtain cash from customers to pay for fixed burden which would not otherwise be recovered. No set rules can be laid down for the fixing of selling prices and the problem is one which constitutes the very essence of trade and commerce and requires, in order to be successful, good judgment as to both buying and selling markets.

In fixing the price of mechanical products to be sold consideration should be given to whether or not the article is competitive or is covered by patents. Articles unless they have some points which make them more valuable to customers, must be priced at competitive levels in order to sell in market. When articles have been patented, it should be considered whether prices are so high that other less expensive, but not so satisfactory articles may be used by customers. When considering competitive prices the price fixer must know whether or not similar articles are being sold at so-called "cut-throat" prices rather than at fair prices. It may be that competitors in order to hurt the manufacturer's business, may quote prices on merchandise at a loss in order to eliminate the manufacturer from the market.

The price fixer must also estimate the various volumes of merchandise which can be sold at various prices. For example, an article selling for a profit of 10 cents may be sold in volumes which will produce a \$1,000 profit while if the same article were priced at 20 cents profit each, the total profit may amount to only \$250. The price must not be set so high as to discourage demand.

**To Make or Buy**—The processes of cost estimating are often employed to determine whether to make or to buy. Where this is the object comparison must be made between the estimated cost to make the article and the purchase cost. According to Culliton (Make or Buy) there are three methods for making such comparisons:

- 1 Preparation of complete budgets
- 2 Localized budgets
- 3 Increment cost method

Culliton states that the most obvious way of finding the cost of two proposed actions is to make successive **complete budgets** of the expenses of the entire business under the conditions which will be in existence if each of the proposed actions is adopted. This procedure is too cumbersome and, therefore, Culliton advocates use of a **localized budget** that is, a budget limited to the specific objective to be covered by the cost estimating process. Thus in a company facing a problem of reconstructing its printing plant destroyed by a flood the localized budget would call for an estimate of the cost of procuring the printing requirements of the business under two conditions.

- 1 Assuming that the plant was rebuilt
- 2 Assuming that the printing requirements were purchased

In contrast to the method of localized budgets which limit the area covered by the estimate is the **increment cost method** which limits the items of cost to be included. As stated by Culliton:

In general those costs which are not changed by either action need not be considered. The reason for this is obvious inasmuch as costs which remain unchanged (sometimes called fixed) would appear in equal value in both budgets (i.e., the budget of the cost of making, and the budget of the cost of buying) and might just as well be omitted from both. This method of cost analysis frequently is referred to as the **increment cost method** inasmuch as it considers only those costs which are added to (or subtracted from) current costs.

In arriving at a decision both internal and external factors are to be considered. Of chief concern here are the internal factors which must take account of the following:

- 1 The budget period i.e. the effect of time on comparative costs
- 2 The effect of volume on comparative costs

In all make-or-buy problems the time factor is an important consideration. Either the actual time span of the costs must be identical or specific attention must be given to the differences. Thus, the amortization of the cost of dies, tools, etc., affects the unit costs depending on the life span assigned to them. The effect of volume is exercised through the spreading of fixed charges.

In the illustration below (Fig. 2), taken from Culliton (*Make or Buy*), there is presented a summary of detailed cost estimates on four different manufactured parts. The comparison is made of the purchase price against the total variable cost rather than against the total cost of production. The following computations then show the most advantageous policy to pursue:

1	If all parts were made the costs would be		
	Total variable costs	\$3 653 26	
	Total fixed costs	<u>1 232 17</u>	
	Total Cost		\$4,885 43
2	If all parts were purchased costs would be		
	Total purchase price	\$2 903 30	
	Total fixed costs	<u>1 232 17</u>	
	Total Cost		\$4 135 47
3	If parts in examples Nos. 1 and 3 were made and parts in examples Nos. 2 and 4 were purchased costs would be		
	Variable costs—		
	No. 1 (Steel Bushing)	\$1 011 05	
	No. 3 (Solid Steel Stud)	520 90	
	Purchase price—		
	No. 2 (Hollow Steel Stud)	884 00	
	No. 4 (Knurled Steel Roll)	339 30	
	Total fixed costs	<u>1 232 17</u>	
	Total Cost		\$4 038 02

The policy adopted by the company in question was the one revealed in the third course of action. It shows a cost of \$97 45 less than the second which in turn was substantially less than the first.

ITEMS	EXAMPLES				
	No 1	No 2	No 3	No 4	Total
Hours	849 5	883 1	216 9	193 4	1 642 9
Labor and Variable Over head Cost	\$ 597 65	\$ 1 510 10	\$ 370 90	\$ 330 71	\$ 2 800 80
Cost of Material	414 00	102 90	150 00	177 70	843 90
Total Variable Cost	\$1 011 65	\$ 1 612 30	\$ 520 90	\$ 508 41	\$ 8 658 90
Fixed Costs	262 12	662 33	109 07	145 05	1 232 17
Total Estimated Costs	\$1 273 77	\$ 2 274 63	\$ 630 97	\$ 653 46	\$ 4 885 43
Purchase Price	\$1 110 00	\$ 884 00	\$ 620 00	\$ 389 30	\$ 2 003 30
Excess Purchase Price Over Variable Cost	\$ 08 35	\$ -798 80	\$ - 90	\$ -110 11	\$ -749 96

FIG 2 Comparative Estimated Cost Summary

**FACTORS IN COST ESTIMATING**—Cost estimating becomes a science when costs are the result of ascertained causes and deductions. The necessary prerequisites of cost estimating are expressed by White

- 1 Complete drawings and specifications of the product are needed
- 2 The approximate volume requirements must be known if a sound estimate is to be made
- 3 The forecast cost of purchased raw materials must be determined by a study of future commodity markets
- 4 Sources for quotations on purchased parts must be available if sound prices are to be secured on details or subassemblies which would be made outside of the plant. The estimating or purchasing department often is required to estimate what a proper quotation from a supplier would be
- 5 Proper wage rates need to be established
- 6 Available methods, processes and equipment should be understood if the capacities and possibilities of the plant are to be estimated to the best advantage
- 7 A good cost system is the foundation of sound estimating. Cost department records should form the proof of all estimates. Burden rates need to be correctly established for all existing centers. New operations, processes, or departments may require new rates to be determined by cost department studies

In addition to above, the following factors should be considered

- 8 Previous estimates
- 9 Previous actual cost records
- 10 Time available for production

**PREVIOUS ESTIMATES**—The fundamental basis for all estimating is that no action or proposal is ever entirely new in all respects, there are always some elements in any new product or procedure which are repetitions or modifications of previous operations or activities. For instance, a new model motor car is similar to previous models in many respects. A material amount of time may be saved in making use of previously estimated items or parts, which are component parts of the product on which an estimated cost is desired. Even specialized mechanical products of entirely new design are fabricated by means of basic operations such as casting, forging, cutting, drilling, grinding, etc. Similarities of design and applicability of physical laws and relationships are factors which contribute much to sound estimating of costs. Even

though a casting of a certain size and shape has never been manufactured, a knowledge of cost experience with other kinds and sizes of castings yields a useful basis for predicting what the new type will cost. Hence, a large part of all cost estimating consists of accumulating and interpreting data concerning costs of operations which are either identical, or at least similar, to the ones proposed. Making proper adjustments or allowances for difference between what has been done and what is to be done yields a reasonable forecast of the cost of the proposed venture. Concerning this point, White (N.A.C.A. Bulletin, vol 19) states:

Estimating standards are established by analyzing the elements of cost experienced on products that have been made. By comparing corresponding elements of cost on similar types of products, the determinants and their influence may be realized. The relations found between the determinants and the elements of cost can be averaged and if judged practical accepted as estimating standards. When a new product is to be estimated it is classified for each element of cost according to its significant determinants. The standards established for the classification of determinants is a factor with which the cost of the element is computed.

Previous estimates are also useful in comparing and checking completed costs of the product as a whole due consideration having been given to changes in labor rates, material costs, plant equipment and layout. If comparable accounting costs are available, a good idea of estimating errors to be avoided can usually be had. Often, the only means of safeguarding the completeness and accuracy of a cost estimate is to make sure that mistakes or omissions in previous estimates are not repeated.

**PREVIOUS ACTUAL COST RECORDS**—Cost records are the actual records of the costs of products already made. They may contain a record of the article to be estimated or reestimated, or the cost of similar products. They may also contain the cost of various units or component parts which can be used in the estimate.

This idea is expressed by Williams (N.A.C.A. Year Book, 1939) as follows:

It is the responsibility of the estimator to translate the design data into terms of necessary expenditures for material, labor, patterns and tools. The first step is to ascertain the costs of devices or parts previously produced. This presupposes an available cost file which shows the detail of material and labor costs segregated in such a manner that the material price and wage levels existing when the cost was prepared are readily determinable. If previous costs are to be used for estimating purposes, it is also important that they be free of variable factors, such as excess spoilage, reoperations, excess material costs and other items of like nature.

**Cost Sheets as Sources of Estimates**—Much specific information is compiled and preserved on cost sheets with respect to particular jobs, processes and classes of product and operations performed in making them. Then, too, accounting records compile and preserve data concerning departmental activities and corresponding costs. Accounting records of the cost sheet type can sometimes be employed to estimate costs of similar products by mere correction for price changes in the cost factors. Even if the product for which costs are being estimated is not exactly the same as that previously produced, the cost sheet may

serve as a starting point in estimating, since the list of operations performed may serve as a check list against which to set up operations on the new product.

**TIME AVAILABLE FOR PRODUCTION**—By time available is meant the time for the production of the specified quantities of product to be made. If a customer desires, for example to purchase a product, one unit to be delivered each day for a month while another customer may wish deliveries to be made two per day over the following 15 days, the estimated cost may be materially affected. It may be necessary, on account of the limited time for production of the articles to pay bonuses, premiums, or overtime. The cost of building, machinery, tools and equipment may be affected by the time element as in order to produce merchandise within the time specified additional or new buildings, machinery, tools, and equipment may become necessary.

**TECHNICAL RELATIONSHIPS**—For many manufacturing activities there exist a number of technical relationships between cost and other factors which are helpful in making cost estimates. These patterns may be scientifically calculated in terms of specific formulas, or reduced to a graph or table for use by the estimator. On this point Williams states (N A C A Year Book, 1939)

For special apparatus approximate estimating tables can be developed by analyzing the costs experienced on like products previously produced to determine the cost influences of the various characteristics of the product. By comparing and plotting cost values against varying characteristics such as size, weight, area, etc., the relation between these factors and their cost values can often be determined within practical limits.

To illustrate, this consider an assembly consisting of steel laminations which are punched out and slotted. We find by analysis that the material

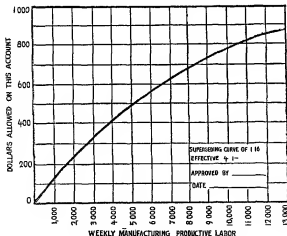


FIG 3 Relation of Productive Labor Payroll and Expense Allowances

costs will vary according to the diameter of the punching and the number of punchings in the steel. The labor will vary according to the number of slots and the number of punchings. We can plot the costs against the number of inches of stacked punchings (which determines the number of punchings), the diameter of the punching and the number of slots. Knowing these characteristics we can determine from the chart the approximate cost values of various combinations on which estimates are required.

Some of the patterns, as in the above illustration, are not concerned directly with cost yet may be extremely useful in cost estimating. Other types of relationships show a direct connection to costs. Fig 3 from Sinclair (Budgeting), shows graphically the relation existing between payroll for direct labor at various levels of activity and expense allowed at each level. Similarly Fig 4 from Gardner (Variable Budget Control) shows a specific item of expense, indirect labor, in relation to productive labor in a punch press department. Such graphs furnish useful short cuts to the estimator.

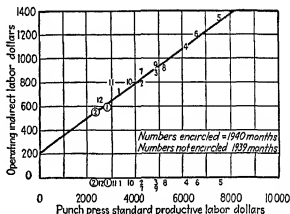


FIG 4 Indirect Labor Related to Departmental Direct Labor

**UNIT COSTS**—Allied to technical relationships are estimates expressed in terms of unit costs. Many cost estimates are made by establishing certain kinds of "estimating units," i.e., setting up some basis for relating costs of a proposed venture to past experience. For example, to secure rough estimates of the costs of building construction floor area or cubic content bases are often employed. These methods rely upon an assumed relationship between area or volume of a building and its cost.

Thus, a residential building may be calculated to contain approximately 31,320 cubic feet by referring to dimensions on the architect's drawings. For buildings of similar type and quality past experience may indicate a "cube cost" of 50 cents. The cost of the house would thus be estimated at \$15,660.

The purpose of such analysis is to make possible comparison between estimates covering different programs or plans. The choice of a cost unit is dictated by convention or custom. In the case of construction estimates the square foot of floor area, or the cubic foot of space are the usual cost units. Sometimes, however construction costs are expressed "per room" or "per apartment." Power plant construction costs may be expressed in terms of horsepower or kilowatt capacity units. Castings, forgings and other parts may be expressed per pound or per piece.

Another use of unit costs of this character is in the nature of a rough check on the completeness and accuracy of the detailed estimate. Despite the fact that estimates made from such unit costs alone are usually not reliable a comparison of unit costs calculated from detailed data with "rule-of-thumb" unit costs may serve to indicate large discrepancies. Unit cost checks can be worked out with respect to specific products or processes and may serve to avoid mistakes of omission of items in the detailed process of estimating.

**ESTIMATING STANDARDS**—Where technical relationships are soundly established they acquire the characteristics of standards. Such estimating standards, according to White (NACA Bulletin, vol 19), are defined as

established values, indices or methods to be used with judgment for predicting any element of the cost of a product. The value of any cost element is influenced by certain characteristics of the product which might be called determinants. Therefore, the cost of a product which is the sum of its cost elements is a function of its determinants. If the influence of each of these determinants be known any combination of these determinants would indicate the cost of the elements and hence the total cost.

To illustrate the method of establishing estimating standards imagine a labor operation (loading a limited variety of products into a standard container) to consist of four elements, and the time required for each is found to be influenced by a single determinant as follows:

Element	Determinant Variations
1 Prepare Container	Constant for this Operation
2 Obtain Product	Weight 15 lb, 25 lb 35 lb
3 Count Product	Equipment Scale, Hand
4 Load Container	Method Random Nested

Analysis of all past time studies on this assumed operation might reveal that the average production rate for every combination of the above variable determinants can be summarized in the following production table of hours per container:

Product Weight	RANDOM		NESTED	
	Scale Count	Hand Count	Scale Count	Hand Count
15 lb	04 hr	10 hr	08 hr	15 hr
25 lb	06 hr	15 hr	12 hr	20 hr
35 lb	08 hr	18 hr	14 hr	24 hr

The packing operation on a proposed product is to be estimated. Consideration of the product shows that it weighs 18 pound would probably be random packed, and counted by weight. The above chart indicates a standard time of between 04 hour and 06 hour per container. If 05 hour is judged reasonable, it may be used as the estimate.



Estimating standards if refined with experience, and applied with judgment improve the speed accuracy and consistency of estimating. In some plants standards have displaced time studies for setting actual rates on many operations. This same general procedure for establishing estimating standards may be used for material or other elements of cost as well as labor operations. Fig. 5 shows estimating standards in the form of cost factors for a manufacturer of plate and tubular heaters.

BASIC ESTIMATING DATA			
Casing Fabrication for Plate and Tubular Air Heaters			
1 SPLIT TYPE CASING			
For all air heaters built as a unit with two heat transfer sections joined by a common air inlet connection			
2 SINGLE TYPE CASING			
For all air heaters having a single heat transfer section			
TYPE OF CASING (As defined above)	GAGE OF PLATES Front Rear, and Sides	COST FACTORS PER SQ. FT. ON DEVELOPED AREA	
		MATERIAL WEIGHT Gross Stock Wt. (in lbs.)	LABOR MAN HOURS
FOR PLATE HEATERS			
Split Type	1/4	14.5	50
Single Type—Air Openings on Sides	3/16	16.5	50
Single Type—Air Openings Front or Back	1/4	17.0	48
FOR TUBULAR HEATERS			
Split or Single Type	3/16	16.5	47
Split Type or Single Type	Same as B P	15.5	57
Split Type or Single Type	# 12	11.0	58
For erection weight deduct 10% from gross stock weight			
DEVELOPED AREA is the total external area for front, rear and sides including the area of air inlet and outlet openings and of boiler casing plates or cover plates which are integral with the air heater casing			
GROSS STOCK WEIGHT is the gross weight of material taken from stock including standard stock size plates, bars and structural members, bolts, nuts, rivets, welding rod, etc.			

FIG. 5 Estimating Standards as Cost Factors

**SCOPE AND PURPOSE OF ESTIMATE**—Although different situations require some variation in method, there should be a general order of procedure for making cost estimates applicable to most cases. The content of cost estimates differs as the purpose of the estimate varies. Also, different situations require varying degrees of accuracy of

computations. Greater accuracy demands more than proportionately greater expenditure of time, effort and money. Hence, to avoid needless waste of these factors it is necessary to establish the scope and purpose of the estimate before analysis and calculations begin.

For instance, a cost estimate to establish a minimum selling price on a special order when the plant is operating at less than full capacity might be made on a differential rather than an average cost basis. But if the cost estimate is to be employed to decide whether or not to replace present equipment, or for the measurement of the efficiency of management or workers, a different approach must be employed to secure proper figures.

An additional factor in the estimate is the size of an order, whether it is a relatively small item or covers a comprehensive program which involves large amounts of capital shifts in important policies or procedures, or important trade and financial relations.

**ANALYSIS OF PROJECT**—Cost may be estimated by analyzing the project in one or more ways mentioned below:

- 1 Separation into parts
- 2 Separation by operations
- 3 Separation by cost elements
- 4 Special methods

**Separation into Parts**—Estimating manufacturing costs is usually facilitated and made more precise by analysis of the product into its component parts before estimating units are chosen. For instance if the product for which costs are to be estimated is an electric table stove, estimating is facilitated by considering separately the wire heating element, porcelain base, chrome plated frame, connectors, plug, and cord. The best illustration may be obtained from the construction industry. While this is not a manufacturing industry, it has some of characteristics of manufacturing and many of its problems. Thus building estimates are usually found to be more precise if the problem is approached by estimating the various parts of construction separately. If costs of excavation, walls, floors, roof, etc. are estimated separately the points of similarity and difference between the proposed venture and past experience can be more easily allowed for and these individual estimates when combined yield a more trustworthy total cost figure. Two buildings might have same cubic content and floor area but different wall dimensions, although there is a relation between floor area or cubic content and costs of construction, this may not apply in the same way to two buildings of similar over all size, but different shape.

**Separation by Operations**—Another basis of analysis of the product or project often employed in estimating is that of operations or processes necessary to production. This method is used along with or in addition to the separation of parts referred to above. For instance making a certain part for a mechanical device may involve casting, drilling, milling, grinding and polishing. Recognition of these specific operations facilitates estimating labor costs and also increases the precision of the estimate.

**Separation by Cost Elements**—If the operations required to produce a given product or part can be definitely stated, it is an easy matter to

break down each operation into its respective requirements of direct labor and direct materials. Overhead may be estimated by means similar to those employed in cost finding operations; i.e. indirect costs may be computed as a percentage of one or both of the other two cost elements, or as a rate per man hour, per machine hour, etc.

**Special Methods**—Just as in cost accounting it may be advisable to ascertain unit costs on a class cost basis estimated costs may be established by relating the proposed product or procedure to a similar class of product produced in the past. For instance castings are usually estimated at a certain rate per pound but this rate is generally higher for larger and more complex castings. Hence estimating foundry costs may be a matter of classifying casting to be made as to size and configuration.

### Items in Cost Estimate

#### ESTIMATING COSTS OF MECHANICAL PRODUCTS—

The principal divisions, besides the estimate for material, labor and overhead into which the estimating of the cost of mechanical products may be subdivided are

- 1 Design time
- 2 Design data
- 3 Drafting time
- 4 Use of building machinery etc
- 5 Patterns jigs and special tools
- 6 Experimental work

**Design Time**—The cost of time spent in designing mechanical products may be estimated on a basis of similar jobs previously made or on a basis of good judgment of the designer as to how much time is required to design the product. On new and complicated products the cost estimator consults designer frequently as design time may become a large and costly item to be considered in the estimated cost.

It is recommended in the calculation of design time that standard rates per hour be used to cover the cost of designers' time and that no attempt be made to use actual rates which are usually paid on a monthly or salary basis.

If several kinds of designers are used in designing new products, they may be classified into groups and standard time rates be fixed per hour for each group, which standard rates may be used in calculating cost estimates.

**Design Data**—The engineering department must furnish information regarding specifications of product to be estimated. Details vary with circumstances and the extent to which the proposed product departs from standardized data. Because of the time and expense factors involved, complete drawings and bills of material are not always supplied at this stage. Williams (N.A.C.A. Year Book, 1939) shows a combined estimate and promise sheet (Fig. 6). This acts as a request form and as a summary of estimated costs. A copy of the form is returned to the sender of the request for an estimate. A supplementary estimating



data sheet is made out by the engineering department (Fig 7) This form insures that the principal parts of the product are properly covered, and calls immediate attention to parts not previously manufactured. As stated by Wilhams

estimating data given should be based upon similar designs already produced, and from a design standpoint should provide for application of parts and materials already designed and for which tools, dies, and fixtures are available. When products or parts are completely new it will be necessary to provide data as to the kind, quality, and approximate weights of materials to be used together with such sketches, layouts, or descriptive information as are necessary to indicate manufacturing and tooling requirements.

COST ESTIMATE AND PROMISE SHEET										
GE 123		VOLTS 300/600		DATE 1/11		NAME E 40 113				
QUAN	SHEET NO 1	TOTAL SHEETS 2	Bo	Use or Similar to	WEIGHT		MATERIAL		LABOR	
					Gross	Net	Kind	Reb	\$ %	
									\$ %	\$ %
1	Magnet Frame			N 10/12/21		500	B4110			
1	Covers - Top			N		10	1/4" S			
1	- Bottom			N		10	1/4" S			
1	Axle Cap P.E. Skerlining			M GE121		140	M1			
1	C.E.			M GE121		140	M1			
1	Frame Head P.E.			N 10/12/21		30	1/4" S			
1	C.E.			N		40	M1			
1	Bearing P.E.			N 100						
1	C.E.			N 101						
1	Bearing Cap P.E. Outer Smaller			M GE122		30	M1			
1	P.E. Inner Smaller			M GE122		28	M1			
1	C.E. Outer			M GE122						
1	C.E. Inner			M GE122						
	FRAME TOTAL									
200	Exo. Pole Leg.			N 10/12/21		1	1/4" S			
40	Keys For 18 stacking			M GE122		5	B6A6			
16	Rivets			M GE122						
40	Exo. Coil Flanges Spool			M GE122		2	1/4" S			
40	Exo. Coil Pads			M GE122						
40	Exo. Coils Flat Wound			N		310	W Cop			
	Arm Dia 4 Turns 1/2 x 4/16 x 1/2									
	Fr. Dia 6 Turns 1/2 x 4/16 x 1/2									
	FIG. TOTAL									
40	Comm. Pole Body 5' x 1/2 x 1/8			N		10	H6B10			
8	Wipe 1/2 x 3/4 x 1/8 Welded			N		2	B7A5			
8	Coil Flanges Spring			M GE122		1	B6A3			
20	Comm. Coils Edgewise			N		300	W Cop			
	10 Turns 1/2 x 5/16 x 1/2									
	COMM. TOTAL									
1	Brush Holder Yoke			M GE120						
40	Bodies Use Cost of			M GE99		10	B5A10			
40	Supports			M GE99						
8	Lever Combinations			M GE99						
8	Studs & Porcelains			M GE99						
8	Brushes			M GE99						
	BRUSH HOLDER TOTAL									
	Continued- Page 2									
(All figures are illustrative only.)										

FIG 7 Detail of Material Requirements for Cost Estimate

**Drafting Time**—Practically all mechanical products require drawings for use of shop mechanics. The cost of drafting time on a new product may be estimated by an experienced draftsman on the basis of his experience after he has analyzed the product as to its component parts and probable time required for the drawing thereof. For the purpose of calculating the estimated cost of drafting time, standard rates per hour may be established for draftsmen who may be paid on a monthly or yearly salary basis. These standard rates can be made so that they will be substantially the same as if the more laborious method of calculating actual rates were used.

**Use of Building, Machinery, Tools and Equipment**—Careful consideration should be given to use made of a manufacturer's buildings, machinery, tools, and equipment, or expected use of these assets in the manufacture of the product on which a cost estimate is to be computed. The cost of a product is affected by the use of buildings, depending upon the layout and location of the building in respect to the main plant, transportation facilities to and from one building as compared with another, and maintenance cost of one building as compared with another.

The cost estimate may be affected by the use of different machines. One machine, requiring expensive upkeep and a large amount of insurance and depreciation taxes etc., may be used to reduce labor costs; or another, a cheaper machine, may be used, thus reducing maintenance, depreciation, insurance and tax costs, but increasing the labor cost. These comparisons must be made and determined upon as to which is cheaper or better.

**Patterns, Jigs, and Special Tools**—Many jobs demand preparation of special patterns, tools, or other devices. When special tools, dies, jigs, fixtures, patterns, core boxes, flasks, etc., are required for the production of a product, the cost estimator must be careful to include the cost of these items in his calculation of the probable cost of the product. The quantity to be made or sold must be divided into cost of special tools, dies, jigs, etc., so that a portion of the expenditure for these items may be recovered in the price of the article sold.

Care should be taken not only to include the cost of special tools, etc., but also the cost of their upkeep during the time product is being produced.

In considering the cost of tools and patterns, the planning department should incorporate as far as possible standard parts or modified standard parts so that standard patterns and tools may be utilized. Unless there is assurance (in the form of contracts) that such items are useful for future production, the usual practice is to include the total cost of special items of equipment in the job estimate, irrespective of the prospects of repeat orders. In case repeat business develops better pattern equipment and more economical tools can often be made for subsequent orders. Job printing plants for example ordinarily consider composition (typesetting, electro-plates, etc.) chargeable in full to the specific job, even though the plates may be of use in subsequent reprintings of the same material. Special plates are sometimes turned over to



the customer, or held for future use, but costs are considered in full as a cost of first run.

All ordinary tools, dies, jigs, fixtures, patterns, etc., on which the cost estimator has previously estimated the cost or which are required for simple operations, may be safely estimated by him without any assistance. If the number and cost of tools or other equipment is sufficiently great, these may be estimated on a separate sheet of a form similar to that of Fig 8 shown by Williams. However, the cost estimator must consult with the tool designer or master mechanic in all cases which involve the making of new tools or reconditioning of old tools for new uses. Together they establish routings for special parts decide on tools to be made and estimate their cost.

**Experimental Work**—The estimated cost of experimental work can only be an estimate based on the judgment of the cost estimator, designer, or engineer. When estimating the cost of new kinds of products especially new inventions which have not been previously produced and which are usually in an undeveloped stage, the cost estimator must be careful in making reasonable allowances for experimental work usually required. The main points to be considered in estimating the experimental cost of new articles is involved in determining equipment, labor, material, and time required to conduct experiments. These may be conducted with standard or special equipment. If standard equipment is to be used depreciation and repair cost to put it back in as good a condition as before the experiment was started, should be included as a part of cost. It may be necessary to build special equipment and its entire cost may become a part of cost of the experiment. On the other hand, certain parts may be salvaged, and in such a case due allowance should be given to the value of parts recovered.

In conducting experiments it is sometimes necessary to use materials or products which after use, may become worthless. The estimator must ascertain how much material is to be consumed during the course of the experiment and take into consideration any salvage therefrom. He must also determine what class of labor is used in making the experiment. In some cases, the services of highly trained mechanical, electrical and chemical engineers may be required, in others, services of ordinary grades of shop operators. In either case, due allowance must be made for supervision of those carrying out the experiment.

Of considerable importance in presenting a cost estimate are excess costs arising at the time of putting a new or special product into production. There are also excess losses due to manufacturing difficulties, changes in design, etc. Estimate must also consider any unusual packing requirements as for foreign shipments, long ocean voyages, etc. (For detailed discussion of Research and Development Costs see Section 21.)

## Estimating Quantity and Prices

**MATERIAL AND LABOR QUANTITIES**—The results of the analysis of a project are in the form of a number of sheets on which lists of specific operations on particular parts are listed. On a simple job these consist only of a schedule of materials required (Fig 9) and a sheet showing the operations to be performed, space being left for time



[illegible]

**Fig 9 Bill of Materials Sheet**



plating factors for which allowances must sometimes be made. These are

- 1 Material quality
- 2 Scrap and defects
- 3 Abnormal quantities

DETROIT MACOID CORPORATION COST ESTIMATE SHEET FOR PLASTICS							
CUSTOMER <u>Hudson Motor Car Co</u>		DATE <u>April 30 1940</u>					
ADDRESS <u>Westland</u>		PART NO <u>5</u>					
NAME OF PART <u>Front</u>							
DESCRIPTION		QUANTITY	UNIT COST	TOTAL COST	COST PER C PCS		
<b>MATERIAL COST</b>							
MATERIAL DELIVERED		79 0	70	5530			
CREDITS: SPRUE 15 5 %		12 5	45	551			
SCRAP 3 %		25	45	11			
BURN 11 4 %		9	0	0			
TOTAL CREDITS		21 5	26	564			
NET MATERIAL COST		57 5	864	4966	998		
<b>PRODUCTION</b>							
GROSS 100 0 %		50 6					
SCRAP 5 %		27					
BURN 5		0					
TOTAL SCRAP 5 %		27					
NET PROD. PIECES 94 5 %		4979					
		HOURS	RATE	TOTAL COST	COST PER C PCS		
<b>LABOR &amp; BURDEN COST</b>							
MOLDING LABOR		17	400	68	1366		
FINISHING LABOR				7 0	146		
FINISHING BURNISH 25 %				525	1054		
TOTAL OPERATING COST				1950	3826		
<b>SUMMARY</b>							
STATISTICS		MATERIAL COST		4966	998		
NUMBER IN MOLD 2		OPERATION COST		1950	3826		
MACH. PROD. PER HR 290		COST OF INSERTS		1001	20		
WGT. OF 1 PIECE 5 GRAMS							
WGT. OF 2 PIECES 50		TOTAL COST WITHOUT MOLDS		2519	5025		
MATERIAL NO. AW 1702 MS		DIALS & ADM. @ 30 %		72 5	1447		
ESTIMATOR		MOLD COST @ 10 000 PCS			5000		
64 mold. hrs @ \$500.00		@ 50.000 PCS			1000		
		@ 100.000 PCS			500		
PRICES QUOTED	COST	PROFIT	PRICE	TOTAL COST @ 10 000 PCS	11477		
WITHOUT DIES	\$6470	647	7117	@ 50 000 PCS	7477		
WITH DIES @ 10 M	11477	1294	12771	@ 100 000 PCS	6977		
OF 1 M	7477	998	8475	REMARKS	Process made extra as in time for 50 hours		
OF 2 M	6977	647	7624				

FIG 11 Detailed Cost Estimate Sheet

**Material Quality**—If goods can be purchased to exact specification, and rejected if they fail to conform to standard quality, then the only problem in connection with variations in quality of raw materials is that of timing or scheduling. This must be done so that delays and bottlenecks are avoided. Some goods may not be available to fit specifications exactly, or grading of materials produces too great variations in quality. In such cases, consideration may have to be given to the advisability of employing substitute materials. In this connection it is important to note that a substitution of one kind or quality of material for another often affects other items besides materials costs. Shifting from one specification for materials to another involves changes in the method of manufacture which affect labor and overhead costs even more than those of materials alone.

Sometimes estimator must be able to plan a job as well as estimate it, i.e., he may be called upon to select items of material to be employed, in such a way as to minimize costs. It is then necessary to make comparisons between sizes, thicknesses, or other variations of specification to select the best of a number of choices. Large organizations in which cost estimating is sufficiently extensive and important, find it advantageous to prepare schedules showing variations in price for various sizes of the same item or differences in shipping procedures. Fig 12 represents such a schedule as used by Williams (N.A.C.A. Year Book, 1939).

**Scrap and Defective Materials**—Scrap arising from production is generally regarded as an offset to direct materials cost to the extent of its recovery value. This value may be a market price less estimated or actual costs of realization or an estimate of the useful value of scrap materials in other productive operations. A troublesome point with regard to scrap or defective materials is that the cost of a particular lot of product may be substantially affected by variations in the amounts of scrap or defects. However, for cost estimating purposes, only a normal allowance for scrap and defects is included in the cost analysis. Thus in Fig 18 normal scrap is estimated at 2%.

Defectives may be allocated to overhead and applied to all products on a uniform basis when the products are of a sufficiently similar nature to result in approximately the same amount of defectives per number of units produced. However, where due to the intricacy of the castings to be produced or the machining operations, considerably more defectives occur on one type of product than on another going through the same shop, then obviously better costing results from charging defectives to such products rather than applying them to all products through the medium of overhead rates.

A distinction must also be made between process waste and spoilage. Thus in a foundry, gates and sprue represent process waste, while blow holes in the finished castings are spoilage. Feden (N.A.C.A. Year Book 1939) formulates the following rules governing scrap costs:

- 1 The percentage of process scrap to be used in the determination of a standard cost should preferably be based on a normal year's record of production and scrap.
- 2 The percentage should be separate for each size lot or material employed.
- 3 If two or more kinds of equipment are employed to manufacture the same kind of product each resulting in a different percentage of



material yield, managerial policy should decide whether to adopt the higher yield as standard and reflect the lower yield as an excess cost or to adopt the lower yield as standard and reflect the higher yield as a gain due to efficient operation

- 4 The percentages of spoilage to be used in calculating standard material costs should be those percentages which prevail after all experimentation and development have passed and the production is proceeding at the standard volume and at the standard speeds for machine and labor performance
- 5 In calculating the percentages for waste and spoilage the deduction should be made by departments that is the resulting yield should be calculated against the full cost of the product entering a department and should include a calculated loss for the material labor and burden up to and including the burden center where the loss occurred

While these rules are formulated in connection with the establishment of standard for scrap, they apply with equal force to the work of the estimator. Peden also presents Fig 11 to show the effect on cost of waste and spoilage. The material cost in Fig 11 is raised from \$70 to \$864 per pound because of recoverable waste (sprue and scrap) and irrecoverable "burn" or spoilage.

**Abnormal Quantities**—It is occasionally necessary to take into account variations in price because of unusually small or large orders of materials. The quotation sheet should indicate the size of the order contemplated in the prices given. Peden (N A C A Year Book 1939) shows an estimate sheet (Fig 13) made out for four distinct quantities. All quotations made by this company are specifically stated to be for definite quantities.

The importance of quantity on estimated cost is shown by Williams (N A C A Year Book 1939).

If the quantities upon which the estimate is to be based are considerably in excess of those previously produced it may be economically sound to extend the use of tools, dies, and fixtures and even to change manufacturing methods.

Estimator must maintain close contact with the purchasing office to secure the kind of quotations which are applicable to the particular items in question, in quantities in which these will be required. Since the great majority of materials required for a given order are ordinarily carried as regular inventory, this caution need apply only to unusual items. In some cases estimating forms are designed so as to allow space for a stock position report from the stores department (Fig 14). The advantage of this arrangement is that the necessity for special purchases or price inquiries may be seen and noted on the estimate sheet before the estimate is completed. This helps to avoid tie ups of production because of materials shortages, as well as to indicate the need for new or special price inquiries.

**ESTIMATES OF OPERATING LABOR TIME**—Estimating the cost of labor on mechanical products, as a general rule involves more computations than that of estimating the cost of material and burden. The cost estimator must have a knowledge of the operations to be performed. To estimate labor with any degree of accuracy, labor operations should be written down in detail on specially prepared sheets and

DEPT	Ch	Quam	sur	file	file
2	30			25	
2	57	1000		1	
3	30			8	
3	503	M			
3	12	1000			
14	36	1000			
14	36				

file	5	20	5	20	5	20	19	000
man	1,000	2,500	5	20	5	20	19	000
lg by	C	M	M					
deg	28	6						
zht								
o	33	th	M					
M	31	65	C	M	T			
out	10	44	10	54	10	54	10	54
o	14	67	5	93	8	41	7	47
in	25	11	2	37	18	85	17	71
10%	17	58	14	26	13	30	12	58
out	42	69	34	63	33	65	30	45
in	74		74		74		74	
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all operations should be listed in sequence. If the article to be manufactured is composed of various minor assemblies, each minor assembly should be broken down into its component parts and labor operations on the parts should be listed in detail.

Where time and motion studies are not available, the estimate should be prepared in consultation with foremen and supervisors. Where a full job evaluation program based on scientific time and motion studies exists, wage differentials may be established taking into account skill, responsibility, and working conditions. The time required depends on machines selected for job, method of production, and efficiency of the operator. If machinery is to be employed in production, the list of operations suggests types and sizes of machines on which work is to be done. If special machine set-ups are required, these must also be listed on the estimate sheet. In estimating set-up time, the cost estimator should have available in his files standard set-up costs on all ordinary products. In extraordinary cases, or where he is in doubt, he should consult with production department or master mechanic in making a set-up cost estimate. Thus the estimate sheet shows the time estimates for all steps necessary to production.

**ESTIMATED LABOR COSTS**—Labor estimates are prepared on the basis of costs of similar parts previously produced or by estimating from sketches, layouts, or other descriptive data. After the project has been properly analyzed to show the specific operations to be performed, labor time estimates are set up in terms of these specific operations. Labor cost of any operation is thus a function of

- 1 Operation time required
- 2 Wage rate paid

Since time estimates are expressed in terms of specific operations on particular kinds of machines, the going rates for indicated tasks are applied to time estimates to obtain direct labor cost in dollars. Piece rate wages eliminate the need for time estimates for direct labor. But time estimates for costing setting-up operations must be included.

The cost estimator may avail himself of information as to the expected future cost of labor by keeping in close touch with the labor market reflected in current trade publications, information made available through trade associations, and through consultation with the manufacturer's own personnel or employment staff.

The detailed labor cost estimate sheet (Fig. 15) is a specimen cost estimate of a center bracket which may be a part of an assembly. The form shows the estimate number, the date of the estimate, name of customer, part number, drawing number, and a short description of the piece and material required. Under the heading "Department" are shown the department numbers in which the operations are performed. In the next two columns are shown the name and number of the operations and machines used. These operations are set up in sequence, i.e., in the order in which they are to be performed. The next section of the form shows cost of operating labor and output on which the estimate of labor cost is based. Here are shown the rates paid for the different labor operations and the cost per thousand pieces. Subtotals are provided for the total labor in each department so that the burden rates can be easily applied. If the burden is applied on an hourly basis the

number of hours instead of the dollar amounts should be totaled by departments. Finally, the estimate shows the estimated cost of burden, which in this case is based on labor cost.

**Set Up Cost**—Set-up cost is separated from the regular operating labor cost so that the total set-up time may be calculated on the basis of the number of pieces to be made on the order. Regular operating labor cost per thousand tends to remain constant no matter how many pieces are made. The total cost of set-up time represents the cost for all the pieces made. Thus a section of Fig 15 shows set-up cost detailed as to set-up hours, rate paid per hour, and cost of each set-up operation. There is also shown a subtotal of set-up costs in each department. These subtotals are made for the purpose of facilitating the application of overhead or burden on a departmental basis.

**Social Security Taxes**—Employers' taxes for old age benefits and unemployment compensation represent additional costs to the business and should be considered a part of the cost of production. Since these employers' taxes are based upon a flat percentage of the payroll, they constitute additions to labor costs. For cost estimating purposes, percentage adjustments to direct labor costs to allow for employers' payroll taxes are in order.

**Bonus Payments**—Bonus payments may be either of the overtime or incentive variety. Overtime and incentive bonuses are, in the opinion of many cost accountants, treated as overhead costs, even when such bonuses are paid to workers whose wages are otherwise direct costs. The consensus of opinion seems to be that such payments are to be treated as Profit and Loss or Cost of Sales adjustments, but are not to be included in inventory unless overtime is a regular feature of a plant's operations or a customer has authorized its incurrence in order to speed production. In the latter event the bonus becomes a direct charge.

Incentive bonuses are justified by the saving in overhead which arises from more efficient production and higher output per unit of time. The effect of some types of incentive bonuses is to reduce the unit labor cost, while in other cases only unit overhead costs are reduced. Hence it seems best to treat such bonuses as overhead, since otherwise if they are treated as added direct labor costs, increased efficiency is reflected in higher direct labor cost.

The estimator must check with the planning department to ascertain the amount of work scheduled on various machines or in various departments. If a job is given a definite completion date, there should be some assurance that work already scheduled does not entail overtime work. Regardless of accounting procedures involved if acceptance of order involves payment of overtime bonuses, the cost estimate should reflect that fact.

**PRICE TRENDS**—There are times when it becomes necessary for cost estimator to go outside his own department in order to confirm his own knowledge of sales conditions, financial conditions and production facilities. In these cases and in every case where there is a doubt, he should consult with sales production, and financial departments, especially where the business at stake may be of considerable volume. The cost estimating department should supply prices for catalog price sheets.



and quotations on special work which are to be used by the sales department when contacting customers. It should at all times keep in close touch with all sales activities and the sales department should keep it informed as to changes in sales policies and market conditions. Sales department is first to come into contact with competitive merchandise and competitive prices and should transmit any information

tools and equipment

**MATERIAL PRICE TRENDS**—Expected future prices or cost trends of material are always available to the cost estimator through trade journals, daily newspapers, and he may use as a basis, the judgment of the manufacturer's own purchasing department personnel. According to Peden (N A C A Year Book, 1939), where material standards are predetermined at the beginning of a fiscal year, the following points must be observed:

- 1 The prices should be based on the prices prevailing for normal quantities rather than for small lots
- 2 The prices should be f o b the company's plant
- 3 The prices should be specific with regard to quality, grades, brands, etc.

Where cost data are based on predetermined estimating standards, it is necessary to put them on a replacement cost basis by converting them to expected prices for materials and wage levels for labor. Thus Williams (N A C A Year Book 1939) cites the experience of one manufacturing company making periodic forecasts of probable market prices of materials (Fig. 16). These are in the form of a general list which shows the relation of expected market prices to the standard price list. As stated by Williams:

Where the material has a base price, as in the case of metals, changes are shown in terms of the base price; otherwise they are projected as percentage increases or decreases.

Under this scheme detailed price lists need not be reissued, and estimating cost standards are readily readjusted to any desired market base.

**ESTIMATING OVERHEAD COSTS**—The degree of precision desired in the final cost figure is an important element in determining the method of assigning overhead. For example, it often happens that a given operation can be performed in more than one way, by the use of alternative methods or equipment. If, however, the scheduling of



other work happens to encompass the entire available time of certain items of equipment, the costs must be reckoned in terms of alternative methods or available equipment. Since there is bound to be some difference in costs of various methods, an accurate cost estimate must take into account the amount of work already scheduled. But if the estimate need not be so precise costs may be reckoned in terms of the method ordinarily employed for such production.

**Predetermined Overhead Rates**—Burden rates used in estimating may be subject to future changes if for example the article on which an estimate is to be calculated is expected to be produced in large quantities, and may be produced in separate or isolated parts of plant, perhaps requiring more or less lighting, heating or power expense more or less indirect labor, machinery tools, and equipment than if produced in smaller quantities or in departments where other merchandise is manufactured. In general, the same method of burden application should be used on the cost estimates as is used in the manufacturer's cost system. This enables the cost estimator and cost department to compare estimates with actual costs and thereby to set up relative standard costs.

However, it is not always advisable to use for estimating purposes the burden rates regularly established for cost purposes, because to do so might at times penalize the job being estimated. As stated by Nevins (N. A. C. A. Bulletin vol 16)

It should be borne in mind that for the most part standard burden rates used to distribute burden to the cost of a product include pattern tools and drawing expenses as part of their component items. In figuring the cost of special items it is well to deduct from the standard burden rate, that part which is represented by the contribution to the total expense of the expense of the pattern tool and drawing departments. The costs of patterns tools and drawings are being added in as separated items and to use the standard burden rates would penalize the job to what may be a considerable extent.

**Set Up and Operating Rates**—If a high degree of precision is desired in the cost estimate, it is common practice to establish set up burden rates as well as operating rates for overhead costs in a given production center (Figs 15 and 17). In addition to segregation of set up overhead from operating overhead, it is sometimes advisable to break down the operating rate for machine overhead into two parts recognizing that some items of overhead do not change much if at all as the rate of output or activity fluctuates. In other words segregation of fixed and variable costs may require the use of two rates or calculations for overhead costs: a standing machine rate (calculated from the relationship of fixed overhead to nominally available operating time) and a running rate (calculated from the relationship of the variable overhead to the time the machine is operated at regular speed). In making cost estimates to aid in price or output decisions it is imperative that some segregation of these dissimilar types of cost be made, the establishment of both standing and running machine rates makes possible more precise estimates for purposes in which differential rather than normal costs are required. (For methods of applying overhead, see Sections 19 and 20.)



**ESTIMATED COST SUMMARY**—Specific calculations and extensions refer to only parts of the estimate, and must be presented in summary form. Where the number of detailed estimating sheets is large it is common to find a summary sheet in the estimate file. Such a summary sheet shows the totals of individual estimate sheets with perhaps a percentage analysis or other explanatory and interpretive comments.

A form for summarizing costs of labor, material, and burden is shown in Fig 17, the cost summary. If it is necessary to calculate the estimated cost of several parts making up a complete unit or assembly, detailed labor cost of each part is made on a form similar to Fig 15, and cost of material required on a form similar to Fig 10. Costs as shown on Figs 15 and 10 are then summarized on a cost summary sheet, similar to that shown in Fig 17. Provision is also made on this form for summarizing the estimated tool cost. The latter is shown separately in the summary as it may be advantageous to set a price based not only on the cost of tools for the immediate requirements, but for estimated future requirements as well.

Total costs as summarized on Fig 17 include quantities, the number of pieces estimated, cost of set-up labor, cost of operating labor per piece or per thousand pieces, material cost each or per thousand and total material and labor cost shown under column marked "prime cost." Burden cost is also shown divided into set-up burden and operating burden and the total of all these items makes up the cost of the article.

A typical summary sheet for an industrial plant is shown in Fig 18 taken from White (NACA Bulletin, vol 19) and designed not only for estimating, but also to accumulate actual costs on the job when it is put into production. The form shows a summary of an estimate on a 2-inch solid red rubber ball. The weight of material required is estimated from a knowledge of the specific gravity of this type of rubber. Assuming a specific gravity of 1.2, the weight of rubber is computed at 18 pound. To this is added an estimated amount for shrinkage, yielding a total weight of 20 pound. At a price of 15 cents a pound, this yields an estimated cost of 3 cents for the material. In the same way details are worked out for the various labor operations. Burden is computed in the form of departmental labor cost rates using 200%, 150%, and 100% respectively, for preparing, vulcanizing, and trimming. Additional cost factors are scrap, estimated at 2% of total material, labor, and overhead, and also shipping costs.

### Short-Cuts in Estimating

**COMMON SHORT CUTS IN ESTIMATING**—Following are the more common short cuts practiced:

- 1 Cost of parts and other unit costs taken from previous records
- 2 Modifying costs i.e. making allowances (plus or minus) from prior cost of standard product
- 3 Use of ratios or flat rates

Short cuts in estimating, like short cuts in any mathematical process, are likely to produce errors. But if these errors are not large enough



## ESTIMATE SUMMARY SHEET

Description BALL - RED NUMBER ESTIMATE NO 1525  
2" Diameter Solid PART NO X-375  
 CUSTOMER ACE SALES CO.  
 DATE 6/1/-

Productive Material 20¢ @ \$.15

Productive Labor

DEPT	DIRECT	LABOR	RATE	TOTAL
1	Prepare	002,0	300	00540
2	Turnsize	00460	150	00690
3	Trim	00300	100	00300

Productive Burden

Scrap 2.4 05610  
 Reoperation /  
 Special T of Costs  
 Royalty  
 Engineering  
 Other Charges

TOTAL MFG COST

Shipping Mail 10 250 Pieces  
 Shipping Labor  
 Shipping Burden  
 Total Shipping Cost

TOTAL FACTORY COST

Commercial Expense

TOTAL COST

Profit /

COST PLUS PROFIT

OUTBOUND FREIGHT—Car Load Allowed

QUOTATION

TOOL SUMMARY			REMARKS
1	Mold 24 Day	250 00	SALES DEPARTMENT NOTE: -
	Dies		1. The above Estimate can be held firm for the third
	Extruder		Quarter only
	Flask		
	Mold		2. This Product is 10% more costly than Part No X-150
	TOTAL	250 00	now sold to this Customer This is due to difference
	Cost of One Mold		in Dies and Extruder.
	Cost—This Est	1,000 Dollars	
	Cost of One Mold	1,300 Dollars	3. The time required to start production on this Product
	Annual Prod	200,000 Pcs	would be two weeks.
	Unit Tool Cost	.00125	

FIG 18 Summary Estimating and Cost Sheet

to cause difficulty, it may be desirable to employ short-cut methods to reduce time and effort required to make estimates

**Cost Estimated from Previous Records**—Where a product, though new is made up of parts some of which are standard the job of estimating is made easier by simply incorporating in the summary of estimate the cost of such standard parts taken from existing cost records. For example, a toy manufacturer is asked to bid on a new doll. The latter is an assembled article consisting of head, trunk, arms, legs, and dress. The estimator merely assembles the costs of various parts from his records. He must know whether the parts are to be composition, rubber, etc., whether doll is to have movable eyes or painted eyes, wig, etc. The estimate in such cases is merely the sum of the parts costs plus assembly material, labor and overhead.

**Modifying Costs of Standard Parts or Products**—It is often possible to prepare quick estimates that are fairly accurate and which require little time to prepare. On the basis of past experience and records the cost data for similar products may be employed for estimating purposes. Thus prior cost records may serve as basis for a cost estimate by allowing for differences between the two.

For instance suppose the new part weighs approximately 10% more than the old and requires some additional machinery, which is judged to require about 20% more machine time. Prior cost record is altered as follows:

	Part 328B14 Prior Cost (100 units)	Quantity Adjustment Factor	Part 731D7 Estimated Cost (100 units)
Materials	\$32.70	110%	\$35.97
Machine Labor	17.50	120	21.00
Machine Overhead	13.00	120	15.60
Totals	<u>\$63.20</u>		<u>\$72.57</u>

Of course such an estimate assumes that no change has occurred in material prices, labor wage rates or overhead cost relationships since part 328B14 was made.

If present unit prices of specified materials used and present rate of pay and overhead cost rate are known, adjustments are easily effected to reflect new conditions. Thus, if the price of material has increased 4% and wage rate for operation has gone up 8% while overhead cost rate has advanced from 85 cents per man hour to 70 cents per man hour, previous calculations could be adjusted as follows:

	Estimate (Original prices)	Price Adjustment Factor	Estimate (Present prices)
Materials	\$35.97	104%	\$37.41
Machine Labor	21.00	108%	22.68
Overhead (at 85¢)	15.60	@70¢	16.80
Totals	<u>\$72.57</u>		<u>\$76.89</u>

In some cases, products have basically standard design and manufacture, but the introduction of special features or modifications makes them special. Williams (N.A.C.A. Year Book 1939) cites as an example

a line of standard motors using basic mechanical parts is produced which requires special drilling special windings or shaft modifications. By analysis of the increase or decrease in costs commonly occasioned by such changes we can prepare tables of approximate allowances or deductions from which we can quickly select the estimated cost.

Another short-cut is possible because for many products costs are dictated by relatively few limiting items, and the cost of minor items varies in proportion to the cost of major items. As stated by Williams,

effort can be directed to the determination of the characteristics and costs of these major items which comprise a large percentage of total costs. For practical estimating purposes this concentration on the details of the limiting items with over all allowances for the balance of the costs is particularly important when dealing with complicated mechanisms.

**Use of Flat Rates**—Some items may be estimated through the use of flat rates per unit of time or product. Thus in connection with engineering expense, the same authority quoted above states:

As a practical measure, engineering, and drafting time is usually taken at a standard rate per hour.

**INDEX NUMBERS FOR PRICE CORRECTION**—Another short-cut in estimating, though not as common as the others, consists of the use of index numbers. If the product for which costs are estimated is complex or if estimates must be made by collecting previous actual costs for price level changes, detailed calculations become time consuming. In many cases, it is possible to avoid a large amount of analysis and adjustment of individual wage rates and material prices. Total material costs, total labor costs, and total overhead charges may be adjusted by means of index numbers. One of the simplest forms of index numbers is illustrated by the following example:

Year	Total Payroll	Total Man Hours	Average Rate per Hr.	Index Number of Wage Rates (1940 = 100)
1940	\$495,000	450,000	\$1.10	100.00
1941	450,000	500,000	.90	81.82
1942	540,000	500,000	1.08	98.18

Use of such an index may be illustrated by assuming that 1,000 units of a given product were made in 1941, the cost sheet for that lot of product showed total direct labor costs of \$5,000. If another lot of 1,000 units of this same product is produced in 1942, direct labor costs may be converted to 1942 wage levels, by the following calculation:  $(\$5,000 - \$1.82) \times 98.18 = \$6,000$ .

**Errors from Use of Index Numbers**—An index number is a kind of average, and weighting of individual items entering into the index affects it to a marked extent. Thus in the case of labor, changes in the index number are due to:

1. Changes in proportionality from year to year.
2. Changes in proportionality of specific job compared with cost center.
3. Price level changes.

Proportionality changes are illustrated in the following figures

	Hourly Rate of Pay	Man hours	%	Total Cost	Average Rate per Hr	Index
1940	\$1 50	195 000	43 $\frac{1}{2}$	\$292 500		
	1 00	150 000	33 $\frac{1}{2}$	150 000		
	50	105 000	23 $\frac{1}{2}$	52 500		
Total 1940		<u>450 000</u>	<u>100</u>	<u>\$495 000</u>	\$1 10	100
1941	\$1 50	100 000	20	\$150 000		
	1 00	200 000	40	200 000		
	50	200 000	40	100 000		
Total 1941		<u>500 000</u>	<u>100</u>	<u>\$450 000</u>	\$ .90	89

Note in the above table that the index number shows a decrease in total average wage rates, even though no reductions in pay for specific jobs occurred, the change in average wages reflects merely a shift in the kinds of work done during the respective years. A greater proportion of medium- and low-priced labor and a smaller proportion of high-priced labor are used in 1941 as compared with 1940.

**Proportionality on Specific Jobs**—Unless weighting of items in the index corresponds to weighting of items on the cost sheet, inaccuracies result. Suppose 1942 computations were weighted the same as 1941 figures

1942	100 000 hrs @ \$1 80	\$100 000
	200 000 hrs @ 1 20	240 000
	200 000 hrs @ 70	140 000
	<u>500 000 hrs Total</u>	<u>\$540 000</u>

The number of hours of high-priced, medium level, and low-rate operations are in the same proportion as in 1941. Hence it might seem that an estimate of \$6,000 for direct labor cost on the proposed lot of product is reasonably safe. But suppose 1941 costs for 1,000 units actually produced were detailed as follows:

800 hrs @ \$1 50	\$ 1 200
1 000 hrs @ 1 00	1 000
5 600 hrs @ 50	2 800
<u>7 400 hrs</u>	<u>\$ 5 000</u>

A detailed estimate of the specific direct labor operations yields a total cost considerably above \$6,000 figure obtained from index number correction

800 hrs @ \$1 60	\$ 1 280
1 000 hrs @ 1 20	1 200
5 600 hrs @ 70	3 920
<u>7 400 hrs</u>	<u>\$ 6 400</u>

The use of index numbers for a specific job reflects a change in wage rates which did not actually occur. It represents merely for that job an assortment of high-, medium-, and low-priced labor different from that generally prevailing on other jobs processed in this department. The error of \$400 is caused by the fact that the relative increase in rates for

high-priced labor (of which little is required for the job being estimated) is smaller than that for low-priced labor (of which a great deal is required). That is, the weighting of high-, medium- and low-priced labor in the index is different from the weighting of the same items on the cost sheet. If all batches of product require the same proportions of high- and low-priced factors, the index number method of adjustment entails no weighting errors. But if these proportions vary from job to job, index numbers must be employed with much discretion, if indeed they should be used at all.

## Errors in Estimating

**HUMAN ELEMENT IN ESTIMATING**—No matter how meticulously the procedure of estimating is established, there is a large amount of interpretation, intuition, and matured good judgment involved in the process. By matured good judgment is meant the innate faculty a cost estimator may have, growing out of his experience, which enables him to estimate the cost of products or component parts, without the use of special data. The fact that most estimating calculations represent some compromise of accuracy for the sake of expediency means that there are no hard and fast rules which can be applied without discrimination. The estimator must be able to supply from his experience, and through the process of logical reasoning, whatever deficiencies there may be in the data open to him. Decisions as to how far analysis must proceed before the component elements of a project reveal similarities to items in past experience, what physical or economic relationships are applicable to those elements, which of several alternative methods is likely to result in least error, must all be based as much on a sense of balance and insight as an objective data. Thus familiarity with the field of operations arising from long and varied experience is a requisite to good estimating, and so is a good practical sense of values.

**SOURCES OF ERROR IN ESTIMATING**—The principal sources from which estimating errors may arise are as follows:

1. Errors beyond estimator's control
  - a. Unpredictable factors such as accidents
  - b. Changes in efficiency of workmen
  - c. Changes in efficiency of equipment
2. Avoidable errors
  - a. Inadequate analysis
  - b. Use of averaged data
  - c. Omissions and duplications

**Inadequate Analysis**—Similarities and differences between complex things can be established with definiteness and clarity only by analysis. Many wrong estimates and wrong costs arise based on assuming a degree of similarity between things which are afterwards found to be different. Yet there are limits to feasibility of analytical work. The major factors are, in terms of practical considerations, the time and effort required, the extent to which analysis is to be carried, is nearly always a matter of expediency, and short-cut methods may frequently be preferred to tortuous and expensive though more precise calculations.

**Use of Averaged Data**—The large amount of averaging involved in costing warrants special emphasis upon averaging as a source of error. All allocations of indirect costs are based upon averaging of some sort, even direct cost allocations often require averaging with respect to price factors. Every cost sheet in a cost accounting system which calls for more than one unit of product, and most estimating processes, involve some application of the averaging principle.

Averages of distinctly nonhomogeneous data are often ridiculous. Yet complete homogeneity of data seldom exists. Averaging arises in part from the necessity for using average figures to reduce a number of different things to a single figure to express a tendency or simplify a problem. The danger is one of oversimplification by assuming similarities or relationships which do not exist. The base upon which an average is computed should be narrow enough to exclude factors which are basically dissimilar. For this reason, a departmental cost rate is more accurate than a blanket rate.

The choice of a base for averaging is a matter of compromise between accuracy and effort. Judgment and experiment are the only means of making such choice, and the cost finding or cost estimating process is therefore always subject to some error from this source.

**Omissions and Duplications**—Cost calculation must omit no relevant factors, and no factor should be counted more than once. Yet it is surprising how often errors of incompleteness and double counting appear in cost estimates and calculations. Errors of this sort are not always easily avoided, but there are some checks which can be applied.

- 1 No estimate should ever be submitted without being checked for omissions and duplications at least to the extent of being reviewed by someone other than the person who made the estimate.
- 2 If the estimate can be compared with some previous job or similar set of operations, there is reason to expect omissions or duplications to be caught.
- 3 Sometimes it may be advisable to check the detailed estimate by comparing it with some kind of short cut calculation to establish a certain amount of reasonableness. Even a comparison with some rough standards or rule of thumb guess may have usefulness in deciding whether or not errors of omission or duplication have occurred.

The best that can be hoped for is that large omissions or duplications are avoided or detected before the estimate is submitted.

## Estimating Department

**ORGANIZATION OF ESTIMATING DEPARTMENT**—The degree of centralization of the estimating organization is answered differently in industrial plants. The advantage of centralization is that it insures speed in the preparation of estimates. Decentralization, however, offers the following advantages:

- 1 Each department having a hand in preparing the estimate feels obliged to meet it when required.
- 2 Entire plant personnel acts as specialized estimating consultants in giving the latest developments, and most accurate information.

Disadvantages of decentralization are stated by White (N.A.C.A. Bulletin, vol. 19)

On the other hand in a decentralized estimating organization there is considerable delay and lost time in passing information through several departments often back and forth. It is difficult to secure complete and accurate transfer of thought progressively through several departments. Information and estimates become distorted and misdirected when handled from person to person. In this type of organization each department is inclined to estimate its own responsibilities conservatively and hesitates committing itself without ample consideration.

Cost estimating may be under the supervision of the sales manager, financial manager, production manager, or general manager. The ideal organization would provide for having the cost estimating division under the direct supervision of the general manager so that it would not be subject to the direct influence of the sales manager, financial manager or production manager and so tend to favor any one of these departments in fixing prices of merchandise.

**FUNCTIONS OF ESTIMATING DEPARTMENT**—The principal functions performed by a cost estimating department are as follows:

- 1 Estimating for the purpose of setting sales prices
- 2 Estimating for setting standards for accounting purposes
- 3 Estimating for purpose of determining whether or not to engage in certain kinds of business

The cost estimating department, in many cases, is also the price fixing department. The price fixing function is not a function which depends entirely on figures prepared by the cost estimating department, as modifications may have to be made to conform with general economic conditions, market conditions, competition, financial structure of the company doing the selling, together with the speculative factor of what all of these conditions may be in the future.

**QUALIFICATIONS OF ESTIMATOR**—Experience of the personnel of the cost estimating department should include both general and cost accounting experience, some engineering training, ability to read blueprints, some production experience, and thorough knowledge of shop layout and equipment, also ability to keep abreast of economic conditions which are constantly changing.

The cost estimator and price fixer requires a knowledge of cost accounting so that he may be able to read cost analysis sheets and cost statements, and to make proper deductions therefrom in using these records for estimating costs. He requires a knowledge of general accounting to enable him properly to determine relative burden charges which prevail at time of making the estimates. He must know why burden rates are going up or down, and must also know the relation of burden rates to general production, increases of cost of material and labor and to assign relative values to these items and determine what figures are to be used in his cost estimates.

The cost estimator must have some engineering ability because he is constantly confronted with problems of estimating on products which have not been previously manufactured and on which regular engineering time cannot be spent. This refers to simple engineering problems and not to those involving stresses and strains, electrical characteristics,

chemical analysis, etc. Cost estimator's engineering ability should enable him to determine whether or not future engineering work is necessary before proceeding with the cost estimate.

One of the necessary qualities of a cost estimator is a thorough knowledge of the plant layout, production methods, and machinery and tools available. If a new product comes in for estimating he should know in all ordinary cases where the product is to be made, what processes are necessary for its manufacture, what price labor will be used, kinds of material which will be worked upon, and what machines and tools are available for its production. He should have a knowledge of tools and equipment on hand so as to guard against estimating on new tools where old ones may be usable. He should know the production capacity of the plant so that he can determine whether or not the time allowed for production is sufficient. He should also keep in touch with the current production so as to determine if space is available in case the order was received and whether it may be necessary to install new equipment or work overtime.

If the cost estimator sets prices, he must keep in touch with the general economic condition of the country so as to determine in his own mind whether or not commodity prices may be expected to increase or decrease, whether labor prices may be expected to rise or fall, whether or not the market will absorb a large or small quantity, whether greater sales effort and expenses are necessary for the distribution of the article to be priced, and determine in advance how much profit may be expected over certain periods of time from the sale of the article at either low, medium, or high prices.

In the organization of a cost estimating department requiring several employees, it may be feasible to employ subordinates who are specialists in various lines of production or specialists in the functions previously mentioned, such as a man familiar with general and cost accounting, an engineer and draftsman, a production man, and a subordinate staff for clerical, stenographic, and filing work.

**ROUTING OF ESTIMATES**—The actual routing of estimates varies. The case of an instrument manufacturer shows the care taken in connection with each estimate. According to Nevins (N.A.C.A. Bulletin vol. 16), a cost report and analysis (Fig. 19) is issued by the sales department in triplicate. It is sent to the cost department where it is read and the procedure determined. It is then forwarded to the planning department where engineering details are worked out on duplicate copy. Specifications for the order are worked out on the reverse side of their copy, and rough sketches of special parts and pattern requirements are prepared.

The methods study department then establishes routings for special parts and tools, and estimates their cost. The drafting department does the same with drawings. The cost department then summarizes the costs on their triplicate copy and returns the estimate to the sales department after approval by the manager. The quotation is sent to the customer, and the request filed. When an order is received, the estimate number is entered on it, for guidance of the production control section. The cost department analyzes the costs on completion of the order and advises sales department, if necessary, of changes in the basis of pricing.





Another company follows the estimating routine described below (N A C A Bulletin, vol 19)

The sales department receives the customers' inquiries and supplies the necessary drawings and specifications. After consulting the estimating department they issue a request to the involved departments for an estimate. The engineering department approves the design of the product and specifies the type and usage of material. The tool department outlines the process lists and prices the tools and equipment. The standards department approves the outlined process and estimates the direct labor cost. The purchasing department prices the material and secures subquotations on purchased details.

The estimating department, a section of the controller's division, coordinates the contributions of the other departments to insure the accomplishment of a sound estimate and fulfillment of the customers and sales departments requests. It checks the accuracy and reasonableness of the estimated material, process, labor, and tools. It applies the burden and summarizes the factory cost. It is also the responsibility of the estimating department to analyze and justify all the details of the estimate. It must prepare when necessary breakdowns and special studies to aid the sales department in determining, explaining and selling their quotation.

**FOLLOW UP OF ESTIMATE**—The estimate is not complete unless actual costs are ascertained and compared with estimated costs. In fact, by using estimates as standards, they can be used to control costs. Variances between estimated and actual costs must be followed up and analyzed to see if

- 1 Actual costs are at fault
- 2 Estimating data need correction

## Estimating Cost System

**DEFINITION**—An estimating cost system is one in which predetermined unit figures for material, labor, and manufacturing overhead are used as a basis for

- 1 Recording costs in books of account
- 2 Comparing such costs with actual costs
- 3 Obtaining variation from estimates

This type of cost procedure represents one of the short cut methods of costing by which it is hoped to obtain the benefits of a full-fledged cost system without the latter's expense.

**COMPARISON OF ESTIMATING AND STANDARD COST SYSTEMS**—Estimating cost procedure is an older type of costing than standard costs. Points of similarity are

- 1 Predetermination of unit costs i.e., determining what costs should be
- 2 Accounts are kept to show differences between estimated or standard and actual costs

Points of contrast between the two systems are

- 1 Standards are, as a rule, more scientifically determined than cost estimates

- 2 Use made of variance accounts
  - a Under estimating cost system variances are used to correct estimates
  - b In standard costs variances are analyzed to determine causes of variation
- 3 Estimates are ordinarily prepared for a given project or batch of goods standards are more universal and are related to plant capacity

Gillespie (Introductory Cost Accounting) differentiates between estimated and standard costs as follows

- 1 Estimate costs are computed on the basis of the best available information, recent cost sheets price files etc modified by expectancy
- 2 Standard costs are based upon engineering studies of performance or expected performance Thus labor times might be determined by scientific time study of standardized operations materials quantities by a study of maximum allowances etc

At best, however, the distinction between estimating and standard costs is tenuous, and represents more a point of view than any inherent differences

**EXTENT OF USE OF ESTIMATED COSTS**—Wherever it is necessary to quote selling prices in advance of production, estimating costs are in order Amidon and Lang (Essentials of Cost Accounting) state

The shoe and clothing industries furnish excellent examples of plants using estimated costs In both of these industries the element of style has become predominant It is necessary to make up samples quote selling prices and take orders far ahead of the actual manufacturing Manu

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'

to be unprofitable

According to Dohi, Inghiam, and Love (Cost Accounting), the estimating cost procedure may be used under any of the following conditions

- 1 Where the manufacturing operations are simple
- 2 Where the products are few and of uniform style, sizes or shapes
- 3 Where there is little variation in cost from one cost period to another
- 4 Where the owners of the business do not require detailed cost procedure or do not desire to incur the expense of a complete cost system

Compared with a complete cost system, estimating cost procedure gives the following results, according to the same source

- 1 Unit costs estimated at first and corrected from time to time to a fair degree of accuracy
- 2 Fairly comprehensive cost analysis
- 3 Cost of sales without the inventory method though based on the estimates and requiring the physical inventory to verify the accuracy of the estimates

**ADVANTAGES OF ESTIMATING COST SYSTEM**—Advantages of estimating cost systems are as follows

- 1 Low cost operation of the system
- 2 Under some circumstances the system yields all information required
- 3 Preparation of estimated cost in advance of production leads to sound sales policy
- 4 The system may be used as a stepping stone to a complete cost system of the standard cost type During transition to scientific cost standards the somewhat cruder cost estimates may serve

**DISADVANTAGES OF ESTIMATED COSTS**—Unit costs being estimated are never quite correct Although corrections are applied at the end of each cost period, the changed conditions during the next period make even the corrected estimates unreliable This point is emphasized by Dohr, Inghiam, and Love (Cost Accounting)

Selling prices may be established on a supposed unit cost which turns out to be grossly inadequate so that many sales have been made at a loss This situation can be avoided to a certain extent by giving careful consideration to possible changes in conditions but the uncertainty can never be wholly eliminated The more complex the manufacturing operations and the more varied the product, the less likely are the estimates to be correct

These authors also point out that where analysis of estimates is by elements of cost

it is not possible to tell how the estimates on the various products agree with actual costs It is entirely possible that factory expense estimates as a whole turn out to be too low but in this situation some products may be shown with factory expenses set too high In the process of adjustment the estimates will be raised so that in the case of a few products the error will be augmented rather than corrected Sales prices based on the estimated costs may result in the reduction of sales where such sales are in fact the most profitable of the entire line

**ESSENTIALS OF ESTIMATING SYSTEM**—The basic requirements of forms peculiar to this system are

- 1 Schedule of Estimated Costs
- 2 Inventory Schedule
- 3 Analysis of Cost of Sales

**Schedule of Estimated Costs**—Detailed discussion of problems confronting the estimator is presented later in this Section The result of an estimator's work is shown in an estimating cost schedule Fig 20 shows standard estimate sheet of United Typothetae of America In Fig 21 is presented a summary cost estimate for a shoe manufacturer The face of the form lists all material charges, the reverse side shows a



UNIT	DATE	SHOE No
DESCRIPTION		
DESCRIPTION		
<u>Upper Stock</u>		
Stock @		
Lace Stay		
Outside Back Stay		
Straps		
<u>Bottom Stock</u>		
Outsole I Gde		
Tap or Middle Sole		
Insole		
Welt		
Counter		
Heel		
Top Lift		
Box Toe		
<u>Linings and Trimmings</u>		
Lining		
Vamp and Top Doubling		
Side Lining		
Inside Heel Stay		
Eye or Butt Facing		
Top Facing		
Fly or Tongue Lining		
Hook or Button Stay		
<u>Findings</u>		
Upper Thread or Silk		
Hooks		
Dyelets		
Laces Butt or Back		
Covers		
Bottom Room Thread		
Shanks and Filling		
Wire and Nails		
Heel Pads		
Leath Repairers		
Cases		
Cartons and Labels		

FIG 21a Summary of Cost Estimate (face)

<u>Labor</u>					
Cutting					
Fitting					
Lasting					
Bottoming					
Edge Room					
Finishing					
Treeing and Dressing					
Repairing					
Packing and Inspecting					
Shipping					
Cripple Allowance					
Royalty					
<u>Manufacturing Expense</u>					
<u>Total Manufacturing Cost</u>					
Selling Expense	%				
<u>Total Cost</u>					
<u>Profit</u>					
<u>Net Selling Price</u>					
Sales Discount	%				
<u>Gross Selling Price</u>					

FIG 21b Summary of Cost Estimate (reverse)

COST ESTIMATE SHEET											
UNIT		Pr		CLASS		WELTS		DATE		STYLE No	
RUN								RUN			
1	Cutting Uppers							45	Stitch Tong Linings		
2								46	Closing Side Linings		
3	Cutting Quart Lin							47	Closing Toe Linings		
4	Cutting Vamp Lin							48	Seaming Side Linings		
5	Cutting Back Straps							49	Cement for Fitting		
6	Cutting Trim & Fac							50	Cement Quarters		
7	Cutting Tong Linings							51	Fitting		
8	Ctg S & Lin or H P							52	Stitching Tops		
9	Ctg Perf or Cut outs							53	Stitching Sides		
10	Ctg Doub or Toe Lin							54	Stitching all Around		
11	Cutting Reinforcings							55	Edging		
12	Cutting Pockets							56	Stitching Eyelet Row		
13								57	Fancy Stitching		
14	Stamping Uppers							58	Stitching Cut Outs		
15	Stamping Linings							59	Stitching Panels		
16	Skiving Vamps & Tips							60	Stitching Pockets		
17	Skiv Quar Fox Strps							61	Eyeltg or E with Hks		
18	Skiving Folding							62	Perforating Tips		
19	Skiving Beveling							63	Perforat Eyelet Row		
20	Burnish Edging							64	Perf Quart Foxings		
21	Mark Tips & Quarts							65	Perforat Vamps, Sides		
22	Crimp Uppers & Lin							66	Closing Foxings		
23	Assembling							67	Seaming Foxings		
24								68	Stitching Foxings		
25	Closing Backs							69	Perforation Stitching		
26	Seaming Backs							70	Stitching Tips		
27	Stitching Back Straps							71	Stitching Boxtoes		
28	Cementing Back Strps							72	Stitching Counters		
29	Folding Back Straps							73	Stitching Tongues		
30	Rubbing							74	Stitch Stays Straps		
31	Stitching Pieces							75	Stitching Buckles		
32	Closing Fronts							76	Binding		
33	Seaming Fronts							77	Closing Vamps		
34	Closing Tips							78	Seaming Vamps		
35	Reinf Vamps Quart							79	Matching Vamps		
36	Cement for Folding							80	Assembling Vamps		
37	Folding Vamps & Tips							81	Assembling Quarters		
38	Folding Quart & Fox							82	Vamping		
39	Folding Stays							83	ad Row Stitch on Qt		
40	Stitching 1st Row							84	ad Row Stitch on Vps		
41	Stitch Saddles to Qt							85	Barring		
42	Pasting Inlays							86	Buttonholing		
43	Opening Linings							87	Lacing		
44	Making Linings							88	Sewing on Buttons		

FIG 22a Detailed Cost Estimate Sheet for Labor and Manufacturing Expense (face)



UNIT		Pr				STYLE No			
RUN						RUN			
89	Buttoning or Buckl g					128	Scouring Heels No 1		
90	Stain g or Ink g Edges					129	Breasting Heels		
91	Sizing and Sorting					130	Scour Heel Breasts		
92	Trim'm'g & Exam'g					131	Doping Heels		
93						132	Trim'm'g Joints No 2		
94						133	Trimming Edges		
95	Pick Lasts & Assem					134	Scouring Heels No 2		
96	Tacking Insoles					135	Setting Edges		
97	Trim Insole Seats					136	Inking Heels		
98	Assembling					137	Burnishing Heels		
99	Pulling Over					138	Cleaning Heels		
100	Side Lasting					139	Buffing Foreparts		
101	No 5 Lasting					140	Naumkeag Forepts		
102	Stapling Uppers					141	Buffing Toplifts		
103	Trimming Toes					142	Blenching		
104	Pulling Tacks No 1					143	Staining Bottoms		
105	Inseaming					144	Waxing Bottoms		
106	Pulling Toe Wire					145	Wheeling		
107	Trimming Inseaming					146	Polishing Bottoms		
108	Pulling Tacks No 2					147	Finishing & Buffing		
109	Trim'm'g Joints No 1					148	Cutting Tacks		
110	Beating Welting					149	Sock Lining		
111	Tacking Shanks					150	Treeing & Cleaning		
112	Filling Bottoms					151	Cleaning Linings		
113	Cementing Bottoms					152	Dressing		
114	Laying Soles					153	Buttoning or Lacing		
115	Rough Rounding					154	Brushing		
116	Opening Channels					155	Trimming		
117	Goodyear Stitching					156	Stamping Bottoms		
118	Cementing Channels					157	Embossing		
119	Laying Channels					158	Stamping Cartons		
120	Leveling					159	Packing		
121	Separating Stitches					160			
122	Seat Nailing					161			
123	Trimming Heel Seats					162			
124	Heel —Leath Heels					163			
125	Heel —Rubber Heels					164			
126	Slugging					165			
127	Trimming Heels								
Cutting Overhead		97				Total Cutting Labor			
Fitting Overhead		67				Total Fitting Labor			
Making Overhead		67				Total Making Labor			
Fin & Pack Overhead		70				Total Fin & Pack Labor			

FIG 22b Detailed Cost Estimate Sheet for Labor and Manufacturing Expense (reverse)

summary of labor and expense charges. Because of the large number of labor operations, these are shown in detail on a special cost estimate sheet (Fig 22). The summary schedule (Fig 21) also shows the method for arriving at a selling price.

**Inventory Schedule**—The presence of an inventory schedule does not necessarily involve taking a physical inventory. Raw material and finished stock ledgers are maintained to furnish perpetual inventory balances. Physical inventory is, however, usually taken to check work in process balances and to estimate their stage of completion. This is stated by Amidon and Lang as follows:

The balance of work in process inventories can be determined by comparing the quantities charged to the factory with the finished production turned over by the factory to finished goods stockroom. For instance the stores requisitions of a garment factory for a given month might show 3 000 yards of cloth has been issued to the cutting room. The schedule of estimated costs is then consulted. This schedule shows the yardage required to make one garment. Assuming three yards to a garment the equivalent of 1 000 garments have been put into process. Next the factory's production report shows that 800 finished garments have been placed in stock. It must be evident therefore that 200 garments are still in process. All that need be done is to estimate the stage of completion which is then listed on the inventory schedule. The inventory is then costed on the basis of the figures contained in the schedule of estimated costs taking into consideration of course the stage of completion. The resulting figure is the work in process inventory which is recorded on the books.

**Cost of Sales Analysis**—When a sale is made, it is necessary to determine cost of sales at estimated cost. Since one sale may cover a range of products, it is customary to analyze sales and summarize their cost on a special summary which serves as a basis for a monthly charge to cost of sales.

**SUMMARY OF ESTIMATING COST PROCEDURE**—The accounting procedure for estimated costs is stated by Amidon and Lang:

1. Open the necessary cost controlling accounts in particular the Work in Process account or accounts their number depending on the degree of verification desired.
2. Stores account is handled in the usual manner on the basis of actual costs.
3. Work in Process is debited for the material labor and manufacturing expense at actual costs, it is credited for the finished production at estimated costs.
4. The inventory or work in process is determined as to quantity by comparing the material issued to the factory with the summary of completed production, or if this procedure offers difficulties by a physical inventory.
5. The inventory of work in process is then priced at estimated costs taking into consideration the stage of completion.
6. The balance in Work in Process account is closed out to a Cost Adjustment or Variation Cost which may in turn be closed out to Profit and Loss or spread as a correction over the work in process inventory and the goods completed during the period.
7. Finished Goods account is debited and credited at estimated costs.
8. Cost of Sales is debited at estimated costs.
9. The estimates after the variation has been calculated are then corrected and the corrected estimates used thereafter.

**VARIATION OF ACTUAL FROM ESTIMATED COSTS—**

Variations present in the Work in Process account or accounts may be disposed of by

- 1 Closing them into Cost of Sales or even to Profit and Loss
- 2 Spreading the variance over the quantity of goods completed during the period. This affects Finished Goods and Cost of Sales
- 3 Spreading the variance over the effective or equivalent production. This affects Work in Process, Finished Goods, and Cost of Sales
- 4 Spreading the variance on the basis of values
- 5 Closing variance into Reserve for Over and Under Variances

By distributing the variance account, estimates are corrected and inventory balances adjusted to bring them in line with the corrected estimates. If the variance is not too large, the difference may be closed to Cost of Sales or Profit and Loss. If, however the difference exceeds a reasonable limit, it is best to go back and apportion it.

**VARIANCES AND COST CLASSIFICATIONS**—Basically an estimating cost system depends on comparison of actual with estimated costs. In obtaining variances the amount of detail depends on the extent of the cost classification. The latter may be kept by

- 1 Total costs
- 2 Elements
- 3 Products
- 4 Departments
- 5 Or any combination of the above

**Analysis by Total Costs**—In the first case mentioned, a single Work in Process account suffices. The balance of the account thus represents a net variation between actual and estimated costs. While this method is cheaper to operate than the other cases mentioned above, it yields less information to management. According to Gillespie (Introductory Cost Accounting),

there is the danger that the net variation may be the balance of a debit variation for certain elements and a credit variation for other elements. Thus the lack of analysis obscures information that is important to the management.

For the other cases, subdivided Work in Process accounts are indicated according to the degree of subclassification desired. Where detailed analysis is wanted for a large number of departments and products the system may break down due to the excessive number of accounts to be carried. In such cases it is best to rely on punched cards and sorting and tabulating equipment to furnish desired data.

**Analysis by Elements of Cost**—The most common method of comparing actual and estimated costs is by cost elements. The following problem adapted from Amidon and Lang (Essentials of Cost Accounting) illustrates the complete accounting procedure.

1 Estimated Unit Cost by Elements	
Direct Material	\$2 00
Direct Labor	3 20
Manufacturing Expense	2 30
Total	<u>\$7 50</u>

2	Actual Costs taken from usual sources of information are		
	Direct Materials and Supplies Issued		\$4 500 00
	Direct Labor		8 500 00
	Manufacturing Expense		1 800 00
3	Production Data		
		Units	
a	Opening Inventory	500	
	Material issued at beginning of process		
	Labor 40% complete		
	Expense 40% complete		
b	Completed and Transferred to Finished Goods	2 000	
c	Closing Inventory	400	
	Material all issued		
	Labor and Expense, 60% complete		
d	Sold	1,500	

## Required

- 1 Journal entries
- 2 Variance distribution over inventories and Cost of Sales on basis of effective production
- 3 Completed ledger accounts for Work in Process Finished Goods Cost of Sales and Variance

## Solution

(1)			
Material in Process	\$ 4 500 00		
Raw Material and Supplies		\$ 4 500 00	
To charge actual cost of material to production			
(2)			
Labor in Process	8,500 00		
Payroll Accrued		8 500 00	
To charge actual labor cost to production			
(3)			
Manufacturing Expense in Process	1 800 00		
Manufacturing Expense		1,800 00	
To charge actual expense to production			
(4)			
Finished Goods	15 000 00		
Material in Process		4 000 00	
Labor in Process		6 400 00	
Manufacturing Expense in Process		4 600 00	
To transfer estimated cost of completed production (2 000 × \$7 50)			
Material (2 000 × \$2 00)	\$4 000 00		
Labor (2 000 × \$3 20)	6 400 00		
Expense (2 000 × \$2 30)	4 600 00		
(5)			
Cost of Sales	11 250 00		
Finished Goods		11 250 00	
To transfer estimated cost of goods sold (1,500 × \$7 50)			

	PHYSICAL UNITS	MATERIAL		LABOR		EXPENSE		Totals
		%	Effective Units	%	Effective Units	%	Effective Units	
1 Opening Inventory required to complete	500							
2 Started and Finished in Current Period	1 500	100%	1 500	100	1 500	100	1 500	
3 Closing Inventory % completed	400	100	400	60	240	60	240	
4 Effective Production			1 900		2 040			
5 Total Variance		\$700 00*	Amount	\$1 972 00*	Amount	\$3 892 00	Amount	\$220 00
6 Variance per unit used as correction factor		\$ 369.42*		\$ 966.67*		\$ 1 417.85		\$ 632.56
7 Work in Process correction		\$147 37*	400 units	\$ 322 00*	240 units	\$ 340 33	240 units	\$ 39 14*
8 Finished Goods correction		184.21*	500 units	483 33*	500 units	708 82	500 units	41 23
9 Cost of Sales correction		368 42*	1 000 units	1 256 67*	1 360 units	1 342 95	1 360 units	217 88
Total Correction Distributed		\$700 00*	1 900 units	\$1 972 00*	2 040 units	\$3 892 00	2 040 units	\$220 00

\* Figures are in red

Fig 23 Variance Distribution on Basis of Effective Production

(6)

Material in Process (New)	800 00	
Labor in Process (New)	768 00	
Manufacturing Expense in Process (New)	552 00	
Material in Process (Old)		800 00
Labor in Process (Old)		768 00
Manufacturing Expense in Process (Old)		552 00
To inventory goods in process at estimated cost		
Material ( $400 \times \$2.00$ )	\$ 800 00	
Labor ( $400 \times 60\% \times \$3.20$ )	768 00	
Expense ( $400 \times 60\% \times \$2.30$ )	552 00	

Variances in Work in Process accounts at this stage are as follows

1 Material estimates too low by	\$ 700 00
2 Labor estimates too low by	1 972 00
3 Manufacturing expense estimates too high by	2 892 00
4 Total estimate too high by	\$ 220 00

These variances are distributed on the basis of the effective production (Fig 23). Note that distribution for material differs from distribution for labor and expense because effective production for these elements varies. As for material, a correction is applied based on 400 units in work in process at the end of the period. Since all material is already issued, the full unit charge is applied. There are 500 units left in finished goods, hence the correction amounts to  $500 \times \$3.6842$ , or \$1842.1. There were 1500 units sold, but of these 500 represented inventory at beginning of period, on which all material had been issued in prior period, hence the correction applies to only 1000 units. By similar reasoning corrections are established for labor and expense.

Entries to record variances and to close the accounts are as follows

(7)

Manufacturing Expense in Process	\$ 2 892 00	
Material in Process		\$ 700 00
Labor in Process		1 972 00
Variance from Estimates		220 00
To close variances in Work in Process and transfer net balance to special Variance Account		

(8)

Variance from Estimates	220 00	
Material in Process (New)	147 37	
Labor in Process (New)	232 00	
Manufacturing Expense in Process (New)		340 23
Finished Goods (New)		41 28
Cost of Sales		217 80
To distribute net variance to inventories and Cost of Sales (see Fig 23)		

(9)

Profit and Loss	11,032 14	
Cost of Sales		11,032 14
To close Cost of Sales account		

## MATERIAL IN PROCESS

Inventory at beginning (500 × \$2 00)	\$ 1 000 00	Finished Goods (4)	\$ 4 000 00
Raw Material (1)	4 500 00	Inventory at end (6)	800 00
	<u>\$ 5 500 00</u>	Variance (7)	700 00
			<u>\$ 5 500 00</u>
Inventory (New) (6)	\$ 800 00		
Correction (8)	147 37		

## LABOR IN PROCESS

Inventory at beginning (500 × 40% × \$3 20)	\$ 640 00	Finished Goods (4)	\$ 4 000 00
Payroll (2)	8 500 00	Inventory at end (6)	788 00
	<u>\$ 9 140 00</u>	Variance (7)	1 972 00
			<u>\$ 9 140 00</u>
Inventory (New) (6)	\$ 788 00		
Correction (8)	232 00		

## MANUFACTURING EXPENSE IN PROCESS

Inventory at beginning (500 × 40% × \$2 30)	\$ 460 00	Finished Goods (4)	\$ 4 000 00
Actual Expense (3)	1 800 00	Inventory at end (6)	552 00
Variance (7)	2 892 00		
	<u>\$ 5 152 00</u>		<u>\$ 5 152 00</u>
Inventory (New) (6)	\$ 552 00	Correction (8)	\$ 340 28

## FINISHED GOODS

Inventory at beginning		Cost of Sales (5)	\$11 250 00
Work in Process (4)	\$15 000 00	Inventory at end	3 750 00
	<u>\$15 000 00</u>		<u>\$15 000 00</u>
Inventory	\$ 3 750 00	Correction (8)	\$ 41 28

## COST OF SALES

Finished Goods (5)	\$11,250 00	Correction (8)	\$ 217 86
	<u>\$11 250 00</u>	P & L (9)	11 032 14
			<u>\$11 250 00</u>

## VARIANCE FROM ESTIMATES

Distribution (8)	<u>\$ 220 00</u>	Work in Process (7)	<u>\$ 220 00</u>
------------------	------------------	---------------------	------------------

**ALTERNATIVE TREATMENT OF MANUFACTURING EXPENSE**—In the illustration above, actual expense was charged to Work in Process. The usual treatment is to charge Work in Process through predetermined expense rates. If the latter method is followed, Work in Process is debited and credited at estimated cost of manufacturing expense. Hence no variance is shown in Work in Process, it appears however, in closing out applied against actual expenses. In place of entry (3) in the above solution, the following entries are made. The ledger accounts are modified accordingly.

Actual Manufacturing Expense	(3a)	\$1 800 00	
Sundry Accounts			\$1 800 00
To charge actual expense to standing orders and proper control account			

Manufacturing Expense in Process	(3b)	4 692 00	
Applied Manufacturing Expense			4 692 00
To charge Work in Process for estimated expense of 2 040 effective units at \$2 30 per unit			

Applied Manufacturing Expense	(3c)	4 692 00	
Actual Manufacturing Expense			1 800 00
Variance from Estimates			2 892 00
To close actual against applied expense and establish expense variance			

ACTUAL MANUFACTURING EXPENSE

Standing Orders (3a)	<u>\$1 800 00</u>	To close (3c)	<u>\$1 800 00</u>
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APPLIED MANUFACTURING EXPENSE

To close (3c)	<u>\$4 692 00</u>	Work in Process (3b)	<u>\$4 692 00</u>
---------------	-------------------	----------------------	-------------------

MANUFACTURING EXPENSE IN PROCESS

Inventory at beginning	\$ 400 00	Finished Goods (4)	\$4 000 00
Applied Expense (3b)	<u>4 692 00</u>	Inventory at end (6)	<u>552 00</u>
	<u>\$5 152 00</u>		<u>\$5 152 00</u>
Inventory (New) (6)	\$ 552 00		

Entry (3c) obviously would modify entry (7) in the first solution





## SECTION 12

### MATERIAL PURCHASES

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## SECTION 12

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### MATERIAL PURCHASES

#### Definitions

**DIRECT MATERIAL**—Direct material is one of many terms used by cost accountants in referring to the classifications of materials and supplies. Other terms are raw material, indirect material, supplies, stores and finished parts. Van Sickle (Cost Accounting) defines direct material as follows:

For an item of raw material to be classified as direct material it must be possible to measure the cost of the material that is applicable to each unit of product or job manufactured.

The Manual of the Machinery Builders' Society defines direct material as

material which can be specifically charged to production orders or to any class or type of product and which forms a part of the finished product also boxes and containers made specifically therefor.

Treasury Decision 5000, Sec. 26.9, defines direct materials as

Materials, such as those purchased for stock and subsequently issued for contract operations and those acquired under subcontracts which become a component part of the finished product or which are used directly in fabricating, converting or processing such materials or parts.

In using the adjective "direct" to qualify the noun "material," it is understood that reference is to product costs, not departmental costs. Accordingly, the term direct material is a matter of definition; material is direct only if it can definitely and conveniently be identified with or charged to a particular product, job, or process. If it cannot conveniently or economically be charged in this way, it should be classed as an indirect material to be spread over production on some logical basis.

Generally speaking, materials present in the finished product are classed as direct materials. However, there are exceptions in the form of direct materials not physically present in the finished article. Thus in the case of a finishing or polishing material consumed in the operation, the material does not become a part of the product, yet it can logically be treated as a direct material cost. When so treated, more accurate costs are secured than when it is treated as an indirect cost. Accuracy of unit costs is the guiding principle which dictates the method for practical purposes. On the basis of this test, cost of material

may be considered and accounted for as a direct material cost, even though that material has not physically or chemically become a part of the product

Practice in various industries is not uniform or consistent with respect to what constitutes direct material. In printing industry it consists of paper, ink, bindery materials, electro engraving, set work, outside machine composition, outside press work, outside ruling and binding, and any miscellaneous purchases used on specific orders.

Other examples are lumber, hardware, glue, varnish and paint in the manufacture of furniture, and steel, tin, lumber, copper, brass, glass, rubber cloth, screws, bolts, nuts, etc., used in the manufacture of automobiles.

As an indication of materials classified as direct in one industry, the list of direct materials contained in the Manual of Standard Cost Accounting for Paint and Varnish Brush Manufacturers is given below:

- |   |   |
|---|---|
| 1 Bristles                                | 8 Nails and rivets  |
| 2 Handles and blocks                      | 9 Paint varnish stain lacquer   |
| 3 Ferrules                                | 10 Stamping paper   |
| 4 Strap                                   | 11 Boxes and labels (including display boxes)                           |
| 5 Rubber                                  | 12 Paper twine rubber bands and other material used in a similar manner |
| 6 Cement or glue                          |   |
| 7 Plugs and strips (or any other fillers) |   |

In many industries a product is not finished until it has been packed or boxed. In such industries, the cost of wrapping and packing material which becomes part of the unit sold to ultimate customer is properly treated as a direct material cost. Thus, in the hosiery industry such packing materials as tickets, labels, bands, paper and boxes are classified as direct materials. In the electric manufacturing industry the cost of cartons and pasteboard boxes in which products are packed for display purposes and for protection while in stock are treated as direct material costs.

Such packaging cost should be distinguished from packing for shipment, which in the uniform accounting manual for the electrical manufacturing industry is described as "boxing" and treated as a separate and direct addition to the cost of goods sold.

**RAW MATERIAL**—Raw material has been defined by Mitchell (Purchasing) as:

Commodities which will be consumed or changed in form during the manufacturing process in the purchaser's plant. Pig iron, wheat, fat, steel, coal and lumber all are raw materials in that they supply the basis for manufacturing operations in well known industries.

In many cases the finished product in one manufacturing stage becomes the raw material for the next. Thus wheat is the raw material in flour milling, but the flour becomes the raw material in a bakery. Again, finished parts purchased representing the vendor's finished product represent the raw material of the purchaser. It is for this reason that the terms raw material and direct material are sometimes used synonymously.

**INDIRECT MATERIAL**—Indirect material has been defined by the Joint Committee on Management Terminology as:

All material which is of a general character no matter how essential to production but which cannot be definitely assigned to a given tangible piece or the making of inventoriable tangible assets

Thus indirect materials cover all those material items not charged directly to the product They are those necessary to manufacturing operations but which do not enter into or make up a part of the article being made Examples are oil, grease, and waste for the machines brooms, rags, and cleaning materials for janitors, and various accounting forms used in collecting cost data Often the costs of certain direct materials used are insignificant and difficult to allocate to the manufactured product and are included under indirect materials Examples are nails used in making boxes, and glue used in bookbinding

**SUPPLIES**—Supplies represent materials used for purposes other than production, classified into a number of functional groups, such as factory supplies, office supplies, delivery supplies packing and shipping supplies None of these enters directly into the product manufactured

**Factory supplies** is used in some concerns synonymously with indirect materials Examples were given above under indirect materials Factory supplies are used in manufacturing operations, but do not become part of article manufactured

**Office supplies** include such items as paper pencils, stationery business forms, stencils carbon paper, ink, etc Those office supplies used in connection with the accumulation of manufacturing cost data may be classed as factory office supplies Other office supplies used are charged to selling and administrative expense

**Delivery, packing, and shipping supplies** include such things as wrapping paper, tags, twine glue cartons, boxes, packing and crating material, etc In most cases these supplies when used are classed with selling expense

Contractors working on government orders are permitted to charge to a Supplies account material which forms a component part of the product but which has not been treated as direct material

Beaudry (N A C A Bulletin, vol 22) suggests the following classification of supplies inventories

- 1 Service supplies
- 2 Maintenance supplies
- 3 Repair supplies
  - a Regular
  - b Spare parts
- 4 Power plant supplies (and fuel)
- 5 Storing shipping and trucking supplies
- 6 Office supplies
- 7 Construction supplies

Comments by Beaudry on the above groups are as follows

The supplies usually become a part of the current expenses when applied However many of the supplies become physically a part of the fixed assets When used service supplies, office supplies and a part of power plant supplies especially fuel become expenses They are ordinarily applied as burden Storing shipping and trucking supplies may be applied as burden or as selling expenses, or partly as both Some of the trucking supplies may become a part of the fixed assets although charged as expense Maintenance supplies and repair supplies are customarily charged to ex

penses or burden but actually the supplies themselves usually become a part of plant or equipment. Construction supplies may, to a small extent, be for repair purposes in which case they may be charged to expenses but, nevertheless they become a part of the fixed asset plant. Most construction supplies, however, flow directly into new plant and are charged to fixed assets.

Materials which enter directly into the finished product but cannot be accurately and economically charged directly to it because of the small quantities used or difficulty of measuring consumption, are often treated as indirect costs. However, in many industries methods have been developed for applying such costs directly through the use of standard or estimated allowances. Thus in the Standard Accounting and Cost System Manual prepared by the Machinery Builders' Society, it is stated that direct materials may be of two types, as follows:

**Allocated Direct Materials**—Materials which can be readily traced to specific units of product should, of course, be allocated directly thereto.

**Unallocated Direct Materials**—Materials such as paint, enamel, japan, acid plating and impregnating substances when they cannot be traced directly to specific units of product may be allocated upon bases such as:

1. Percentage of allocated direct material
2. Percentage of corresponding direct labor cost
3. Amounts per unit of product determined by means of periodical observations, studies, and tests

The use of the term "unallocated direct material" is unfortunate, since allocation on any basis implies that no direct measurement takes place, and, following the basic definition of direct material, the above mentioned items constitute indirect materials. But by applying costs of such material separately rather than in combination with other indirect factory costs a more accurate unit cost is undoubtedly determined.

**STORES**—This is a generic term that includes both direct and indirect materials. It includes all raw material, all direct and indirect materials, all finished parts, and all supplies used in manufacture. Term "stores" is used sometimes to include finished goods. In the latter case the cost accountant differentiates between raw material stores, finished parts stores, and finished goods stores.

**FINISHED PARTS AND PURCHASED PARTS**—Finished parts are considered direct material under each of following conditions:

1. When purchased and assembled into a finished product
2. When manufactured from raw materials in one department or division of a plant, placed in finished parts stores and then reissued for assembling into finished product

Some companies operate largely as assembly organizations, purchasing parts from others, while other companies purchase some individual parts which they are not equipped to produce and combine them with their own products. Such **purchased parts**, when acquired from an independent company or a separate manufacturing division of the same company, are properly treated as direct material costs of the purchasing company or division. Thus, the manual prepared by the Machinery Builders' Society provides that

cost of material parts and devices produced either by an outside manufacturer or by a contributing department may be considered as part of direct material and be shown as such on the summary cost sheet

Government regulations concerning purchased parts on war contracts provide

Material cost includes all purchased materials and fabricated parts entering directly into the product or which are used directly in fabricating, converting or processing such materials or parts. Purchases made specifically for the contract should be charged at their actual prices

In some cases it is considered desirable to account separately for such purchased parts. The Uniform Accounting Manual for the Rubber Manufacturing Industry has, in addition to direct material classification a separate grouping for what are described as extra materials made up generally of purchased parts assembled with the rubber product and packing materials used in connection with finished product

Under modern manufacturing conditions finished parts to a large extent are manufactured to supply replacement parts to consumers. Therefore where finished parts are not used in manufacture but are produced for sale, they become in effect finished goods

## Control of Material and Supplies

**NEED FOR CONTROL**—In general accounting, the common procedure used in determining cost of materials and supplies consumed or sold is to deduct the value of the physical inventory at end of period from the sum of the inventory at beginning of period and the purchases during the period. The assumption is that all materials and supplies that have disappeared during the period have been sold or consumed in production. To make certain that this is the case, careful control over materials and supplies must be maintained, as much care should be exercised in accounting for raw materials and supplies as is used in accounting for money. Since raw materials and supplies are the equivalent of cash, and since they make up an important part of the cost of manufacturing, it is essential that they should be safeguarded and accounted for properly. A thorough control of materials and supplies provides information on the basis of which unfavorable developments may be checked or eliminated. Specifically the advantages of such information may be stated as follows

- 1 Eliminates waste in the use of raw materials and supplies
- 2 Reduces the risk of loss from fraud and theft
- 3 Book inventories are kept which facilitate the preparation of accurate monthly financial statements
- 4 Furnishes quickly and accurately the value of materials and supplies used in various manufacturing departments
- 5 Reduces to a minimum the capital tied up in inventories
- 6 Effects a reduction in investment in storage plant and equipment
- 7 Prevents production delays due to lack of materials by supplying the proper quantities at the right time
- 8 Provides for accountability on the part of those in responsible positions



**ORGANIZATION FOR RAW MATERIALS AND SUPPLIES CONTROL**—Material and supplies control to be effective involves the following activities

- 1 Purchasing
- 2 Receiving and inspection
- 3 Storing and issuing
- 4 Keeping perpetual inventory records

The purchasing department procures all necessary goods of proper quality to produce without interruption, the finished article at the lowest possible cost. In general, the purchasing department

- 1 Receives or originates requests for purchases
- 2 Contacts suppliers for suitable prices and deliveries before writing purchase orders
- 3 Prepares and places purchase orders with vendors
- 4 Follows up these orders to be sure goods have been shipped
- 5 Assembles documents certifying that the proper quality and quantity ordered have been received
- 6 Approves purchase invoice for payment after checking prices and extensions unless this work is to be done by the accounts payable section

The functions of the receiving and inspection department are

- 1 To receive all incoming raw materials and supplies from various transportation agencies, properly signing for the same
- 2 To verify items received by count, weight, etc., reporting all shortages
- 3 To inspect materials and supplies as to quality
- 4 To deliver goods received to the proper point in the plant for storage except when a material handling department performs this function
- 5 To inform the purchasing department of all facts that may require adjustment with vendor

Stores Department performs the following functions

- 1 Receives and checks in all materials from the receiving department
- 2 Stores all goods in a proper place clearly identified through the use of a suitable code
- 3 Issues materials and supplies for use upon presentation of authorized requisitions
- 4 Records quantities received and issued on bin tags or on stock ledger cards constituting the perpetual inventory records

The inventory records department may be a subdivision of the cost accounting department, although in many plants it is part of the stores department. In either case the operating personnel, that is, the stores ledger clerks, take charge of the perpetual inventory records. Where the stores department operates these records the necessity for bin tags is obviated. Thus the functions of purchasing, receiving and inspection, and stores are not the responsibility of the cost accounting department but the activities of the other departments result in documents and reports on the basis of which the cost department operates the formal cost records. (See presentation later in this Section)

## Material Purchasing Forms and Records

**FORMS USED IN CONTROLLING PURCHASES**—Forms and records most frequently found in controlling purchases are

- |                                |                         |
|--------------------------------|-------------------------|
| 1 Purchase requisition         | 6 Receiving report      |
| 2 Request for price quotations | 7 Receiving requisit    |
| 3 Purchase order               | 8 Inspection report     |
| 4 Purchase order register      | 9 Returned goods report |
| 5 Follow up of purchase order  | 10 Voucher charge       |

**PURCHASE REQUISITION**—This is a request by an authorized party sent to the purchasing department to buy materials and supplies needed in the plant

**Form of Requisition**—The form of the requisition varies with the accounting system in use, the need of the plant, and the point of origin. Figs 1 and 2 are typical forms in use. Requisitions should be of a size suitable for filing and different colored paper is used for various copies. Some concerns use a "rush" purchase requisition of different color (usually red) if materials and supplies are needed at once.

**Point of Origin**—A requisition may originate with a storekeeper, a foreman, a department head, or any other individual who is authorized by management to make such a request. In many companies it is the duty of the stores ledger clerk to prepare such requisitions when the supply of stocked material falls below a predetermined minimum as shown on the stock card (Fig 16).

**Number of Copies and Their Disposition**—If the purchase requisition originates with the storekeeper, at least two copies are required. One is retained by the stores department and the other sent to the purchasing agent who keeps it to show his authority for making the purchase. Fig 1 shows a typical purchase requisition made out in triplicate. It is originated by the stores supervisor or, in some cases, by a department manager. The original and duplicate are sent to the purchasing department; the triplicate being retained by the originating department. When the purchase order is issued the vendor, order number, routing, etc. are entered on the requisition and returned to the originating department as a notice that the purchase order has been placed. The original is retained in the purchasing department files and may be filed by commodity or vendor. It is sometimes attached to a copy of the purchase order.

Some accountants, however, feel that the return of the purchase requisition to the originator is unnecessary as involving too much red tape.

Fig 2 shows a purchase requisition used by one manufacturer. While it contains the same essential information as Fig 1, it contains more detailed instructions. The reverse side of the form contains information as to vendor, address, price, terms of delivery, and cash discount. It shows the high degree of material control by the number and kinds of approval required.

**Accounting Effects**—No formal journal entries are required in connection with a purchase requisition. It is often the practice for the stores department to take a physical inventory at the time the purchase requi-



PURCHASE REQUISITION				Date: _____	
IMPORTANT {				To: _____	
Subj: _____				Approved: _____	
C. Name Requisition to One Commodity				Date: _____	
ISSUE IN TRIPLICATE OR FIVE 1. To the purchasing agent 2. To the receiving agent 3. To the accounting agent 4. To the inventory agent 5. To the warehouse agent	DE CR 1-21				
Name of Vendor		P. No. & Amount		Purchase Order	
Last time used		Date of last use		Y	

FIG 2 Purchase Requisition (with detailed instructions)

sition is made out since inventory is probably at minimum and easier to count. Any discrepancies between physical and book inventories are traced and if the error cannot be located, an **inventory over and short** report is made out. The journal entry adjusting the discrepancy is made at the end of the cost period.

**REQUEST FOR PRICE QUOTATIONS**—After the purchase requisition has been received by the purchasing department, it is necessary to determine with what vendor the order shall be placed. Quality of product, price, and ability to make delivery are essential factors in selecting the proper vendor. Information is usually available in the department to aid in this selection. If the buyer is not satisfied that he has proper knowledge, requests for price quotations are sent out to various vendors. These requests are usually sent in duplicate to at least three vendors. One copy is filled in and returned and the other kept by the vendor. The advantages of such reply forms are:

- 1 Uniformity of quotations for tabulating and filing
- 2 Assurance that all points are covered in the quotation
- 3 Certainty that buyer's terms of purchase are either accepted or definitely rejected

PURCHASING DEPARTMENT		THIS IS NOT AN ORDER	
<div style="border: 1px solid black; border-radius: 25px; width: 100%; height: 100%;"></div>			
<p>             IF YOU DESIRE TO ORDER MATERIALS MENTIONED BELOW, PLEASE FILL IN THE FOLLOWING INFORMATION:         </p> <p>             IT IS UNDERSTOOD THAT THE ORDER WILL BE RETURNED TO YOU NOT LATER THAN _____ AND NO CHARGE WILL BE MADE FOR THE ORDER.         </p> <p>             IF YOU DESIRE TO ORDER MATERIALS MENTIONED BELOW, PLEASE FILL IN THE FOLLOWING INFORMATION:         </p>			
YOUR QUOTATION MUST BE FILLED OUT AS ABOVE TO BE CONSIDERED			
CASH DISCOUNT - IF ANY			
STATE DEFINITELY DELIVERY YOU WILL GUARANTEE			
HEREBY UNDERTAKE TO SUPPLY THE ABOVE MENTIONED MATERIALS ON THE TERMS INSERTED IN THE COLOMNS FOR THIS PURPOSE WHICH PRICES INCLUDE DELIVERY F.O.B.			
TO DELIVER THEM WITHIN THE TIME SPECIFIED ABOVE AND TO ABIDE BY THE CONDITIONS SET FORTH ON THE BACK HEREOF			
DATE _____		SIGNED _____	

Fig 3 Request for Quotation

PRICE AND QUOTATION RECORD									
Material _____									
Description _____									
VENDOR	DATE QUOTED	FOR	LIST	UNIT	DISCOUNT	ORDERED			REMARKS
						DATE	ORDER NO	QUANTITY	

FIG 4 Price and Quotation Record

Fig 3 illustrates a form used in securing quotations. In connection with request for price quotations, it is desirable to keep a quotation record card (Fig 4) so that quotations from vendors may be tabulated compared, and a decision made from whom to order.

**PURCHASE ORDER**—The contract with the vendor is entered into by the issuance and acceptance of a purchase order. It gives the vendor authority to ship the required goods and binds the buyer for payment. The purchase order number should be used by the vendor on all invoices and related correspondence. It must appear also on all packages. Use of a purchase order number in the above manner is of importance in verifying the receipt of goods, checking and comparing with invoices, and in identifying future correspondence relating thereto. Instructions covering these points usually appear prominently on the face of the purchase order, and may be further emphasized by clauses appearing on the back of the order.

**Quantity of Goods Ordered**—This must be stated plainly in figures or words, or in both. Frequently clauses are inserted on the order form limiting the vendor's right to overship or undership the quantity ordered unless written consent of the buyer is obtained, for example:

The quantity of material ordered must not be exceeded without our permission in writing being first obtained.

**Description of Goods**—The order must be clear and specific including grade, size, and weight of material required. Clauses should be inserted allowing buyers to return goods in case of failure on the seller's part to deliver exactly the right kind. If materials are ordered subject to any unusual tests, a statement to that effect should be included on order. Clauses that may appear on purchase orders are illustrated below.

All goods shipped subject to our inspection and acceptance upon arrival notwithstanding prior payment to obtain cash discount.

Goods rejected for inferior quality or workmanship will be returned with charge for transportation both ways.

One manufacturing company inserts the following clause on the back of its purchase orders:

All materials furnished must be the best of their respective kinds and will be subject to our inspection and approval at any time within thirty days after receipt. If rejected they will be held for disposition at your risk and expense and any payment on account therefor will be promptly refunded by you.

**Delivery Date**—The date goods are to be shipped or delivered at the buyer's plant should be clearly stated. It appears best to indicate the date of arrival on the purchase order so that responsibility for transportation delays is shifted to vendor. Buyers often reserve the right to cancel an order if there is default in time of delivery. A typical clause covering the above reads:

Failure of shipper for any reason to fulfill delivery as promised will be considered sufficient cause to cancel this order.  
Acknowledge order specifying best delivery.

The following is used by one manufacturer:

Delivery must be effected within the time stated on the purchase order failing which we reserve to ourselves the right to purchase elsewhere and charge you with any loss incurred as a result thereof or, at our own option, to cancel the order.

**Shipping Instructions**—These should include the point at which goods are to be delivered, routing desired, kind of packing required and transportation facility to be used, as express, parcel post, truck, freight, etc. Examples of clauses inserted on purchase orders covering shipping instructions are:

No charge allowed for packing or cartage.

Packing or cartage will not be included in invoice price unless agreed upon in writing.

All material must be forwarded by the route taking the lowest transportation rate (this includes inland and coastwise vessel service) or in accordance with special shipping instructions issued by our Traffic Department, otherwise the difference in freight rates and extra cost of cartage will be charged to your account. When usual terms of tariffs do not include insurance shipments must be forwarded properly insured.

Send advice of shipment as soon as material is forwarded giving correct purchase order and requisition numbers, description of material, car initials and numbers, and routing. For fuel ore pig iron scrap, stone sand and other bulk materials use our form BH 1570a; refractories use form BH 1570b; sending original to Purchasing Department. For all other materials send copy of packing list to general storekeeper.

Material arriving without proper notices will be held until the desired information is received and all costs incidental thereto will be charged to your account.

In addition to the shipping instructions the correct purchase order and requisition numbers must be plainly marked on all material or packages.

For carload shipments cars must be loaded to minimum capacity or the shipper will be charged with the excess freight we are required to pay. Each car must be tagged with the name of shipper and description of material and purchase order and requisition numbers.

**Transportation Charges**—Fob point should be definitely stated in order to avoid disputes. This may be seller's plant, buyer's plant or seller's plant with freight allowed. Provision should be made as to whether the seller should prepay the freight, whether it is to be paid by

buyer, or whether the buyer after paying may deduct it from the invoice price. The following is an example:

When terms of delivery are f o b our works all railroad transportation charges (including terminal switching service) on materials furnished under this order as well as for service in connection therewith must be at your expense in accordance with the tariffs of the transportation lines and railroad companies as lawfully in effect at the time the shipments are moved or the service is performed.

**Billing Instructions**—These should cover the number of invoices required, how invoices should be marked and to what place they should be mailed. A typical example is "Mail invoice in triplicate and original bill of lading to purchasing department." One manufacturer uses the following statement:

Itemized bills in triplicate on forms enclosed must be rendered giving correct purchase order and requisition numbers and sent to \_\_\_\_\_ at the time of each shipment (unless otherwise specified) accompanied by the original bill of lading or express receipt otherwise we cannot prevent delays in payment of the account.

Bills should state terms of delivery, whether f o b destination or point of shipment and whether freight is prepaid or collect. When terms are f o b destination and freight is not prepaid, the amount of freight charges must be credited on the bill.

Send statement of account as soon as possible.

**Prices**—These should be stated in the purchase order if they are based on quotations or prior agreement. Some concerns place prices on all purchase orders. This has the advantage of being certain as to price prior to shipment. The disadvantages are, additional clerical expense on the part of the vendee, and possible loss of price declines unknown to the buyer since the vendor's billing clerks follow the prices stated in the purchase order. Clauses often included in purchase orders affecting prices are:

Orders filled at advance prices without our approval cannot be accepted.

It is understood and agreed that you will not charge, without our consent, a higher price for the goods called for by this order than was last quoted or charged this office.

**Terms of Payment**—Terms must be definitely stated in the purchase order. They include regular cash discounts, special discounts based on quantity ordered, and special terms as to payment by acceptance or draft. The following protective clauses are often printed on the back of a purchase order:

Unless otherwise agreed to, bills are payable between the 20th and 25th of the month following shipment, provided the material has been received. Discount terms named are based upon the assumption that bills will be in our hands within three (3) days from date of shipment, otherwise we will assume that the discount is to be calculated from the date the bill reaches us allowing three days for transmission.

Any moneys due for materials furnished hereunder may at our option be applied by us to the payment of any sums which you or any of your affiliated or subsidiary companies may owe us.

No drafts for purchases made hereby will be honored.



**Miscellaneous Clauses and Conditions**—Some clauses inserted in purchase orders depend upon conditions peculiar to a trade or industry. The following examples are taken from the practice of various concerns.

You agree to protect us against any infringements of patents on materials furnished by you not of our design.

Seller agrees that no part of this order shall be sublet without purchaser's approval.

When cost of tools involved in manufacture of parts covered by this order is included in price per unit, tools become property of this company upon completion of our orders.

This order is confidential between purchaser and seller and it is agreed by seller that none of details connected therewith shall be published or disclosed to any third party without purchaser's written permission.

**Indemnity**—You agree to indemnify and save harmless this Company and other companies directly or indirectly owned or controlled and any purchaser from this Company of the materials equipment articles and/or structures called for by this purchase order from and against any and all costs damages, and/or expenses of any kind or nature whatsoever which may arise out of or result from or be reasonably incurred in contesting a claim by any person firm or corporation that the manufacture purchase use or sale of any of said material equipment articles and/or structures infringes any letters patent and you further agree to indemnify and save harmless this Company from and against (a) loss of or damage to any and all patterns molds templates or materials delivered to you by this Company so long as the same shall be in your possession however such loss or damage may occur and (b) any and all demand or demands of every nature or kind arising out of injuries to or death of any of your employees or any employees of any of your subcontractors while in on or near the premises of this Company however such injuries or death may be caused.

**Workmen's Compensation Laws, Etc**—You agree to comply with all provisions of the Federal and/or State Workmen's Compensation Laws and other applicable laws relating to or affecting the employment of labor.

**Liens**—All material delivered and labor performed under this order shall be free of all liens and if the buyer requests a formal release of all liens will be delivered to the buyer.

**Assignment**—Our purchase orders shall not be assigned in whole or in part without our permission.

**Copies of Purchase Order**—The number of copies of a purchase order to be made varies with the accounting system in use and the purchase procedure involved. At least four copies of the purchase order are usually required (Fig 5).

Original is sent to vendor from whom purchase is made.

Second copy is kept in the files of the purchasing department. It is placed in the 'Unfilled' file until goods are received, after which it is transferred to the 'filled' file. It is used later as a check on the invoice received from vendor.

Third copy is sent to stores ledger clerk who records proper data in the 'Ordered' column of the appropriate stores ledger card (Fig 16).

Fourth copy is sent to receiving department where it is filed according to vendors in an "Unfilled" file. Some plants prefer to block out the quantities ordered in this copy to prevent laxity on the part of receiving clerks in counting the quantities received.


ORD N <u>8274</u> DEPT _____		<b>REMINGTON RAND INC</b> GENERAL PURCHASE INVOICE AND RECEIPT 463 W HINSON ST BUFFALO N Y		PURCHASE ORDER NO <u>G-14697</u>	
T <u>A Screw Co ,</u> <u>Screwville Connecticut</u>		<u>Ilion</u> <u>6/16</u>		AS P C E O SR NUMBER MUST A PERK IS I TO CHA L CASE NO PL NO PL TO LB PL TTT PLU CH PL NO E NO PL ALAO GL	
RT <u>ITA P-835 G</u>		5,000 Screws machine, as per B/P P-6 5 6 Standard Commercial 8-32 tld x 5/8" large oval head brass machine screw			CE <u>0036 each</u>
AVNO <u>RM 387</u>		TERMS <u>2 10-30</u>		FOB <u>Ilion, N Y</u>	
SHIP VIA <u>Parcel Post</u>		SHI AND INVOICE <u>6/1</u>		PM/C <u>317 50</u>	
SHIP TO <u>Remington Rand Inc</u> <u>7 Spruce St ,</u> <u>Ilion N Y</u>		7 Spruce St <u>Ilion N Y</u>		REMINGTON RAND INC 	
ACKNOWLEDGMENT OF RECEIPT OF ORDER					
UPON R PT G TH NO SER PLEASE STASH RTU ADV WLEDGMENT T ACE TO		LOCAL PL HAVING S PARTIME T <b>REMINGTON RAND INC</b> <u>7 Spruce St</u> <u>Ilion, N Y</u>			
W HEREBY ACKNOW EDG REC IPT OF ORDER O <u>G-14697</u> AND AGREE TO F FINISH MATERIAL CIFIED IN EXACT S ORDNANCE WITH O O R. SHIPMENT FROM ED.					
DATE R <u>0</u>		SIGNED _____			
OUR ORDER NO _____		BY _____ DATE _____			

Fig 5 Purchase Order

One large manufacturer finds it convenient to make seven copies of a purchase order. These copies are used as follows (Figs 6a, 6b)

- 1 Vendor's copy Mailed to vendor (Fig 6a)
- 2 Purchasing department copy (tissue) Filed numerically daily
- 3 Requisitioner's copy Sent to department ordering material
- 4 General storeskeeper's copy (tissue) Filed numerically daily
- 5 Accounting department copy Spaces are provided on the back to check against invoices and receiving report (Fig 6b)
- 6 Purchasing department copy (hard) Filed by commodities in proper subdivision of purchasing department
- 7 General storeskeeper's copy (hard) Used as receiving record Spaces provided on back for report of goods received

Unit as ordered order and a not all correspondence regard of this order to <div style="border: 1px solid black; border-radius: 50%; width: 150px; height: 100px; margin: 10px auto;"></div>		194 ACCOUNT NO		PURCHASE ORDER NUMBER REGION T ON NON
SHIPPING INSTRUCTIONS M L 5 pm 1 with sur h rder m d 1 mch d CONSON TO				
DATE WANTED TERMS OF DELIVERY F O R.		SHIP VIA		
PLEASE ENTER ORDER FOR THE FOLLOWING		NO FROM	PRICE	
QU TTY				
RENDER INVOICES IN TRIPLICATE ON FORMS FURNISHED In accepting the order it is understood that you give to terms and conditions shown and also to terms to conditions set forth on the back of this order all of which are hereby and part herof				
				PURCHASING AGENT

Fig 6a Purchase Order



**Accounting for Purchase Order**—No formal journal entries are necessary to record purchase orders. Memorandum entries may be made in a purchase order register or on a daily summary of purchases, such a record may serve as a source for the determination of purchase commitments. It is sometimes very important to know the amount of purchase commitments. The liability of purchasers on commitments may be extremely large and have an important bearing on their overall financial condition. This may be shown by footnoting the balance sheet or by making formal entries setting up the liability on purchase commitments. Memorandum entries are also made in the Ordered section of the stores ledger cards (Fig 16). Postings to the latter also affect the Balance Due and Available columns.

### Receiving and Inspection Forms and Procedure

**RECEIVING**—The procedure followed and forms used in receiving material and supplies depend upon the kind and size of enterprise. In one case when goods are received a receiving report (Fig 8) is made in quadruplicate. After the incoming goods have been checked and inspected they are sent to the stock room with the original of the receiving report. This is to be accepted by the storekeeper and returned for the receiving department's files. The duplicate is sent to the purchasing department for comparison with the purchase order and purchase invoice. The triplicate is sent to the accounting department as authority for vouchering the invoice. The fourth copy is sent to the stores ledger clerk as a posting medium for goods received.

In some companies the copies of the purchase order are used for receiving purposes. In such cases it is usually considered good practice to block out the quantities on the copies sent to the receiving department so that the receiving staff must actually count, weigh or measure the incoming material or supplies without knowing the quantity ordered.

Fig 9 shows a form of daily receiving report used to record all shipments received. The original is sent to the stores ledger clerk to be posted to the stock records; the duplicate is sent to the purchasing department. Use of this form makes a separate inspection report mandatory.

**INSPECTION**—If the receiving department is required to inspect or test incoming materials the results of such inspection or testing should be reported to the purchasing department. This report is often a part of the receiving report (Fig 10). Spaces are usually provided on the latter for signatures and comments of the inspector. However, in large companies special inspection reports are used, their form depending on the nature and extent of the inspection tests performed.

If after inspection, the materials are rejected, the inspector's report should show in detail the reasons for rejection so that the purchasing department or claim clerk may act intelligently in making an adjustment with the vendor. All forms of request for adjustments should be made only on authorization by the purchasing agent or his designated representative. (See accounting for purchase returns later in this Section.)

RECEIVING REPORT				REPORT NO	48072
PURCHASED FROM				A. Screw Co	
SHIPPED FROM				DATE RECEIVED	
SHIPPED VIA				PURCHASE ORDER NO	
P.P.				9-14697	
Screwville, Conn				REQUISITION NO	
CAR NO				8274	
SYMBOL				TRANSPORTATION RECORD	
DESCRIPTION				PRO NO	
XFA-P-6386 Machine screws				WEIGHT	
				25	
				PRY OR EXP CHGS	
				PREPAID OR COLLECT	
				Paid.	
				NO OFFKES	
				CONDITION	
				ex	
RECEIVED BY				SIGNATURE	
A.L.R.				M.P.P.	
INSPECTION DEPT				1	

Fig 8 Receiving Report







- 8 To assist in care of goods in storage and establish accountability for such goods on part of storekeeper
- 9 To furnish basis for materials consumption in preparing statements
- 10 To measure efficiency of material used through setting of standards

**RECORDING PURCHASE LIABILITY**—No accounting entries are necessary when a purchase requisition is forwarded to the purchasing agent, and only memorandum entries are made when a purchase order is sent to the vendor. When materials are received inspected and placed in the storeroom, however, entries must be made

- 1 In the accounting department to record the total cost of purchases and the liability resulting therefrom
- 2 In the stores department to record the quantity and value of each kind of material received on the stock records

After the receiving report has been completed and sent to purchasing department for comparison with the purchase order and purchase invoice the latter, if approved is sent to the accounting department for proper entry. The purchase invoice or copy of receiving report is used by the stores ledger clerk to record proper information on stores ledger cards

**PURCHASE INVOICE**—The purchase invoice is based upon the purchase order and is the vendor's charge for materials supplied. The form of the invoice is usually determined by vendor. Some vendors furnish their own form (Fig 11) for billing which is sent along with purchase order. Fig 11 is furnished to the vendor in triplicate. The back of the triplicate copy contains the following instructions

- 1 Invoices should be rendered on a complete set of these forms. A set comprises the following copies

Original	(Buff)
Office Copy	(White)
Work Copy	(Salmon)

- 2 Should the space on this form be insufficient for itemizing in detail the material shipped or services rendered a brief description and the total value should be shown. Complete details should then be reported in triplicate on either form BF 12 13 14 15 or 16 dependent upon the material shipped. A copy of the details should be attached to each copy of the invoice form BF 11

3 Invoices should state terms of delivery whether "fob destination" "fob point of shipment" "fob point of shipment—freight allowed" "f.a.s." etc also state whether shipment moved "prepaid" or "collect" by crossing out the unnecessary word

4 When terms are "fob destination" or "f.a.s. a named point" shipments should move prepaid. If moved otherwise, proper allowance for transportation charges should be made on invoice. Likewise, if terms are "fob point of shipment—freight allowed" proper allowance for transportation should be made on invoice

- 5 Be sure to fill in correctly every caption on the face of the invoice including our purchase order and requisition numbers

6 The complete set of the invoice together with details in triplicate (if any) and the bill of lading or express receipt should be mailed to the address shown above. Shipping notices or packing lists should be mailed as directed on the purchase order

7 Shippers who comply with the above instructions and the conditions of our purchase order will expedite payment of their invoices. Noncom



pliance may necessitate the return of the invoice thus materially delaying payment thereof

A standard or uniform invoice has been devised by the National Association of Purchasing Agents (Fig 12) Use of such an invoice simplifies the amount of information collected and makes filing easier through adoption of a standard size

When an invoice is received, a rider is attached on the invoice is stamped to show the order in which it is to be routed to the various departments for necessary approval and checking A typical stamp on an invoice includes the following

- |                              |                             |
|------------------------------|-----------------------------|
| 1 Cash discount terms        | 7 Date of receipt of goods  |
| 2 Entered on purchase record | 8 Accounting department O K |
| 3 Approved for price         | 9 Charged to                |
| 4 Buyer's approval           | 10 Date paid                |
| 5 Date received in plant     | 11 Check No                 |
| 6 Receiving report No        |                             |

When the invoice is received in the purchasing department, the date received is stamped on it It is then routed to the purchase record desk for entry and comparison with the purchase order Next it is sent to a price clerk for a check on prices only From there it is routed to the purchasing agent for final departmental approval The invoice then leaves the purchasing department for the accounting department, where it is compared with receiving records, extensions and footings are checked and the proper account is charged through the purchase record The invoice is then sent to the treasurer's department for payment

There are many variations from the above routine, depending upon the size and kind of organization Frequently the invoice is checked against the receiving report in the purchasing department Standing order or job order to be charged is often determined in the purchase department and checked by the accounting department In some concerns the purchase invoice may be sent to stores ledger clerk so that a cost record may be made on the stores ledger cards In checking the invoice the important features to keep in mind are

- 1 Quantity must be checked against the purchase order to guard against over and under shipments also against the receiving report to prevent payment for goods not received
- 2 Where necessary the quality of goods received is determined by the inspection department and in such cases its approval is a prerequisite to the passing of the invoice by accounting department
- 3 Unit prices should be checked by the purchasing department through the use of quotation records catalogs etc
- 4 Extensions and footings are checked usually with the aid of calculating machines
- 5 Terms and discounts available should be carefully checked Cash discounts that may be secured should be on file in the department responsible for paying invoices
- 6 All transportation charges should be checked by the purchasing department and finally sent to the traffic department for approval as to the rate

In connection with the handling of invoices, the accounting department must see that the correct amounts are charged to the proper account or accounts, and that the work of the purchasing department is



adequately checked. The latter is necessary to prevent errors and dishonesty.

**GENERAL ACCOUNTING RECORDS USED**—Records needed in accounting for materials and supplies purchased and received depend upon the accounting system used, as well as the kind and size of business. The following illustrates the variety of records that may be kept in an accounting department for recording the purchase of materials and supplies:

- 1 Simple purchase book or journal
- 2 Columnar purchase journal
- 3 Invoice register
- 4 Voucher register when manufacturing accounts are kept on general books
- 5 Voucher register when a separate factory ledger is kept for manufacturing accounts
- 6 Stores ledger cards

**PURCHASE BOOK OR JOURNAL**—This may be employed by concerns where little control over purchase transactions is needed because of their small number and their simplicity. Totals from this journal are debited to a control account for Materials and Supplies and credited to Accounts Payable. Each creditor's account must also be credited if it is desired to keep detailed accounts with them.

When this form of purchase journal is used, only purchases of materials and supplies are entered in it. Purchases of services or other items are entered in an expense journal, general journal, or cash disbursements journal.

**COLUMNAR PURCHASE JOURNAL**—This is used when purchases are numerous and where there are several classes of commodities purchased and it is desired to keep a record by classes. Manufacturing concerns using this type of journal do not as a rule maintain a controlling account for materials and supplies. Instead, separate material and supply accounts are kept in the general ledger. Fig. 13 illustrates such a journal that may be used by a concern making a simple product. Posting from this book is self-explanatory.

PURCHASE JOURNAL										
DATE	INV NO	VENDOR	TERMS	L F	CREDIT ACCOUNTS PAYABLE	DEBITS				
						LUMBER	HARD WARE	PAINT VARNISH OILS ETC.	MFG SUPPLIES	OFFICE SUPPLIES

Fig. 13 Columnar Purchase Journal

**INVOICE REGISTER**—This is used when there are many creditors, requiring an extensive account classification, and it is deemed to record all purchases, whether for commodities or services, in one book. Its form is the same as for a voucher register except that it has posting reference columns to record postings to the underlying creditors' ledger. As invoices are received, they are recorded before passing on to other departments for posting to subsidiary or statistical records, and thus control is assured. Posting to general ledger accounts is effected through column totals, except sundry items, which are posted separately.

**VOUCHER REGISTER**—This is a basic record used by many manufacturing concerns. It is a combination purchase journal and creditors' ledger. When used in its most comprehensive form all expenditures are entered and distributed here. This record initiates the flow of cost data and facilitates their analysis.

After the purchase invoice has been completely checked as indicated above it is usually attached to a voucher, together with the purchase order and receiving and inspection reports. The voucher constitutes the basis for entries in the voucher register. The auditing department examines all these data, and its approval is necessary before the invoice or voucher is entered and paid. Usually one voucher is made for each invoice. Some concerns, however, accumulate different invoices of the same creditor on one voucher, the audited invoices being kept in a voucher jacket until ready for vouchering and payment. (For accounts payable routine, see Section 5.)

**POSTING TO STORES ACCOUNTS**—The Stores controlling account is posted directly from the appropriate column in the voucher register or other supporting book of original entry. The underlying accounts on the stores ledger cards are posted in any of the following ways:

- 1 Directly from invoices
- 2 From a copy of the receiving report
- 3 Control column in the voucher register may be analyzed at the end of each month on analysis sheets and postings made to the subsidiary ledger from these sheets

In some concerns it is possible to indicate the subsidiary account to be charged as entry is made in the voucher register. This is done through the use of a code or account number alongside the control column. Posting to the subsidiary ledger is then made directly from the code column. In other concerns an analysis sheet is drawn up monthly of items in each control column and postings to the subsidiary ledger accounts are made from this sheet. Likewise, analysis sheets may be used to transfer details of other control columns to their respective subsidiary ledgers.

**PURCHASE RETURNS**—When goods are returned or claims made for adjustment, the vendor is notified at once. This notification may be in the form of a letter or debit memo, illustrated in Fig. 14. If the latter is used three copies may be made, the original being sent to the seller, one copy attached to the purchase invoice or voucher, and the third copy remaining in the purchasing department. If the goods are to be

PURCHASING DEPARTMENT DEBIT MEMO			
M No No _____		Date _____	
Purchase Invoice No _____		Purchase Order No _____	
To _____			
We are debiting your account with the following			
QUANTITY	DESCRIPTION	REASON FOR DEBIT	AMOUNT
Signed _____ PURCHASING AGENT			

FIG 14 Purchasing Department Debit Memo

sent back to the vendor, a return shipping order is also issued by the purchasing agent to the receiving department.

If goods are returned or claims for adjustment are made immediately after receipt and inspection and before the invoice is recorded, only a memorandum record need be kept. This record may be a bound book or register containing the following information:

- |  |   |
|--|---|
| 1 Date<br>2 Name and address of vendor<br>3 Purchase order number<br>4 Purchase invoice number<br>5 Quantity | 6 Description of goods returned or to be replaced<br>7 Value<br>8 Reason for return |
|--|---|

The above record should be kept in the accounting department to act as a check on the disposition of claims by the purchasing department. For formal accounting of purchase returns see Section 5.

**ACCOUNTING FOR PARTIAL SHIPMENTS ON PURCHASE ORDERS**—For various reasons a vendor does not always ship the entire amount ordered. He may be temporarily out of certain items, or a year's supply may have been ordered at one time, with the request that shipments be made in monthly instalments. When partial shipments are received, the usual accounting procedure may be followed, that is a voucher is made out for the amount received debiting Stores and the proper stores cards, and crediting Vouchers Payable. Vouchers for these partial shipments are approved and paid regularly to take advantage of all discounts allowed. In connection with partial shipments notations are made by the purchasing agent and the receiving

clerk on their respective copies of the purchase order, and these copies are kept in the active files until all goods are received. Under this method invoices for partial shipments are supported by a purchase order covering the entire lot.

### Stores Records

**STORES LEDGER**—Stores ledger cards or sheets are basic records in accounting for materials and supplies. When taken together they make up the subsidiary ledger controlled by Raw Materials or Stores control account. They represent a perpetual inventory record. Typical stores records in actual use are illustrated in Figs. 15 and 16. A detailed description of data that may be collected on a stores card is summarized as follows by Dohr, Ingham, and Love (*Cost Accounting*):

**Heading**—The heading of stores card should contain information required for the efficient administration of the stores department as follows:

- 1 Name of item covered by the card, its number or, if a symbolizing system is used, symbol of item. Some care should be exercised in naming, numbering or symbolizing items in order that confusion and error in dealing with goods will be avoided.

- 2 Size, shape and quality of item and the amount of storage space required, kind of space required and storage conditions. This information should usually be given in terms of units of the article.

- 3 Location in storeroom of the article showing, bin, shelf, rack or section in which article is to be found. If more than one storeroom is maintained the card should show the particular storeroom in which the goods are located. Under symbolizing system the symbol should show the location in the storeroom. It should be possible to tell from the card where the article is to be found when required.

- 4 Unit in which the article is purchased and dealt in, together with the usual or most economical quantity in which it can be shipped, having regard to its cost, quality and shipping rates, also the unit in which it is issued or used in production. In this connection attention will have to be directed to the manner in which the goods are packed for shipment, containers, relative cost on carload lots and less than carload lots, quantity discounts, etc.

- 5 Quantities of article used in production in past periods based on production statistics. This figure should be entered for a number of past periods and will be used as a guide in estimating requirements of future periods and placing orders.

- 6 Length of time required to get additional goods. This involves a study of the time required (after it is decided goods are needed) for placing an order with the seller, for the seller to procure or produce goods for transit and for unloading, hauling, and receiving. If goods require a period of storage for "seasoning" such time is also taken into consideration.

- 7 Estimated amounts of material required in the ensuing cost periods. This amount will be based on a study of plans for production and figures for past consumption, together with a tabulation of orders received from customers.

- 8 Maximum and minimum quantities for item. The maximum quantity is the largest quantity which should be on hand at any time and is established after considering the cost of the material, time required to secure it, estimated requirements of the factory, etc., in order to avoid having a large amount of capital tied up in raw materials. Management must always be careful to keep a sufficient amount of working capital available.



STORES RECORD SHEET																					
Requirements										Issued					Adjustment						
Name of Item _____ Classification _____ Symbol _____ Location _____ Store Room _____ Section _____ Bin _____ Size _____ Shape _____										Received Date Per Order No. Quan. Total Unit Price Amount					Issued Date Per Order No. Quan. Total Unit Price Amount					Adjustment Date Debit Credit	
Jan _____ Feb _____ Mar _____ Apr _____ May _____ Jun _____ July _____ Aug _____ Sep _____ Oct _____ Nov _____ Dec _____																					
Maximum _____ Minimum _____ Quantity to Order _____ Source of Supply _____ Time Required _____																					

FIG 15 Complete Balance of Stores Record

and the amount of capital tied up in raw materials reduces the available working capital for other purposes and involves a loss of income which might otherwise be received on the capital. The minimum quantity represents the lowest quantity which should be on hand at any time in order to avoid delays in productive processes due to lack of raw materials. This amount is established after a consideration of time required to secure materials, their cost requirements of factory, etc. Establishment of these two quantities and keeping of goods on hand accordingly insures that two of the objectives of material accounting will be achieved: reduction of quantity of materials on hand to avoid excessive inventories and elimination of production delays due to lack of materials.

The heading as outlined above represents a very elaborate type of control over stores procedure. Under some conditions it would not be necessary to keep all this information for all items in stores. The circumstances of each case should be considered and information not required or useful should be eliminated.

**Ordered Column**—When purchase orders are placed for quantities of an article the entry is made in the Ordered column to show date of order, order number, quantity ordered, and in some instances price. When ordered goods are received a notation should be made in the Ordered column usually by drawing a line through the order which has been filled. By considering goods actually on hand, quantity on order, and quantity reserved it is possible to determine the amount which is available for production in the near future. Only the quantity actually on hand of course is immediately available for issue.

**Received Column**—As goods which have been ordered arrive in the receiving department the balance of stores clerk is notified and entry is made in the Received column. This column shows the date on which goods are received, quantities and price. Price may include invoice price less trade discounts plus transportation charges, costs of unloading, hauling, and in some factories an additional amount is added to cover cost of storage and stores department expense up to the time the goods are used. In some cases entry here will include only the invoice price in which event additional charges are included in the factory overhead. Total amounts entered in Received columns on stores cards are equal to the debit to Raw Materials account on the general ledger. Materials returned to the storeroom from the factory are entered in the stores record, like purchases through Received column.

**Issued Column**—Raw materials issued for use in the factory are posted in the Issued column. This entry shows the date of issue, production order for which it is issued, quantity issued, price and value. Total issues appearing on stores cards will equal credit entry in the Raw Materials control account and Issued column of stores card is a credit column when the card is regarded as a detail or subsidiary ledger account. All other columns, except the Received and Balance columns, are merely memorandum columns so far as a trial balance of the stores ledger cards is concerned. In some cases raw materials are issued for repairs, factory supplies, shipping expense, or for capital account in which cases appropriate entries are made. For goods returned to vendor, entry is made in Issued column.

**Balance Column**—The Balance column shows values of articles on hand at the close of the period. It is ascertained by adding receipts to goods on hand at the opening of the period and deducting amounts issued. The sum of these balances on the various stores cards equals the balance of control account for raw materials. This is ascertained by balancing the stores cards at the end of the cost period and taking a trial balance to

Card No. <u>2</u>		Name <u>Shell, Ratchet Brace, Model A</u>		Location <u>3A10</u>									
Maximum <u>10000</u>		Part No. <u>12</u>		Pattern No. <u>15</u>									
Minimum <u>2000</u>		Material <u>Steel</u>											
		Blue Print No. <u>577</u>											
		Weight											
Ordered		Receipts		Avail.		Apporportioned		Cost per 1000		Issued		On Hand	
Dates Rec'd	Supplier	Order No.	Quant.	Date	Order No.	Quant.	Date	Order No.	Quant.	Net Cost	Average Cost	Order No.	Quant.
						8500	6/12	6130	5000	6.50	6.293	6/1	
						3000	6/12	6131	1500				8500
5/10	5/14 Bureau Mfg Co	17113	8000			8000							8500
				6/10	4000	17115	4000			6.25	6.430	6/1	6130
						10000							8500
				6/17	6305	1000						6/1	6131
				6/17	6306	1000							8500
				6/17	6307	1000							8500
				6/17	6308	1000							8500
				6/17	6309	1000							8500
				6/17	6310	1000							8500
				6/17	6311	1000							8500
				6/17	6312	1000							8500
				6/17	6313	1000							8500
				6/17	6314	1000							8500
				6/17	6315	1000							8500
				6/17	6316	1000							8500
				6/17	6317	1000							8500
				6/17	6318	1000							8500
				6/17	6319	1000							8500
				6/17	6320	1000							8500
				6/17	6321	1000							8500
				6/17	6322	1000							8500
				6/17	6323	1000							8500
				6/17	6324	1000							8500
				6/17	6325	1000							8500
				6/17	6326	1000							8500
				6/17	6327	1000							8500
				6/17	6328	1000							8500
				6/17	6329	1000							8500
				6/17	6330	1000							8500
				6/17	6331	1000							8500
				6/17	6332	1000							8500
				6/17	6333	1000							8500
				6/17	6334	1000							8500
				6/17	6335	1000							8500
				6/17	6336	1000							8500
				6/17	6337	1000							8500
				6/17	6338	1000							8500
				6/17	6339	1000							8500
				6/17	6340	1000							8500
				6/17	6341	1000							8500
				6/17	6342	1000							8500
				6/17	6343	1000							8500
				6/17	6344	1000							8500
				6/17	6345	1000							8500
				6/17	6346	1000							8500
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				6/17	6348	1000							8500
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				6/17	6355	1000							8500
				6/17	6356	1000							8500
				6/17	6357	1000							8500
				6/17	6358	1000							8500
				6/17	6359	1000							8500
				6/17	6360	1000							8500
				6/17	6361	1000							8500
				6/17	6362	1000							8500
				6/17	6363	1000							8500
				6/17	6364	1000							8500
				6/17	6365	1000							8500
				6/17	6366	1000							8500
				6/17	6367	1000							8500
				6/17	6368	1000							8500
				6/17	6369	1000							8500
				6/17	6370	1000							8500
				6/17	6371	1000							8500
				6/17	6372	1000							8500
				6/17	6373	1000							8500
				6/17	6374	1000							8500
				6/17	6375	1000							8500
				6/17	6376	1000							8500
				6/17	6377	1000							8500
				6/17	6378	1000							8500
				6/17	6379	1000							8500
				6/17	6380	1000							8500
				6/17	6381	1000							8500
				6/17	6382	1000							8500
				6/17	6383	1000							8500
				6/17	6384	1000							8500
				6/17	6385	1000							8500
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				6/17	6391	1000							8500
				6/17	6392	1000							8500
				6/17	6393	1000							8500
				6/17	6394	1000							8500
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				6/17	6396	1000							8500
				6/17	6397	1000							8500
				6/17	6398	1000							8500
				6/17	6399	1000							8500
				6/17	6400	1000							8500
				6/17	6401	1000							8500
				6/17	6402	1000							8500
				6/17	6403	1000							8500
				6/17	6404	1000							8500
				6/17	6405	1000							8500
				6/17	6406	1000							8500
				6/17	6407	1000							8500
				6/17	6408	1000							8500
				6/17	6409	1000							8500
				6/17	6410	1000							8500
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				6/17	6413	1000							8500
				6/17	6414	1000							8500
				6/17	6415	1000							8500
				6/17	6416	1000							8500
				6/17	6417	1000							8500
				6/17	6418	1000							8500
				6/17	6419	1000							8500
				6/17	6420	1000							850

show that the aggregate balances on the stores cards are equal to the Raw Materials control balance

**Apportioned and Available Columns**—Fig. 16 illustrates a further step in the development of stores cards with Apportioned and Available columns. When priorities are involved or materials are required in the near future for specific production orders, apportionment is made on the stock record. The materials are still in physical possession of the storekeeper but no longer available for other orders, and the stock card entries are made to note this situation.

Reserved	
Date _____	
Job	Dwg. and Mark
No. Pieces	Name of Material
Date _____	
Job	Dwg. and Mark
No. Pieces	Name of Material
LOCATION	

FIG. 17 Material Reservation Card



**DETERMINING PURCHASE COST**—All costs incurred in getting raw materials and supplies into the plant up to the point of use are reflected as inventory cost on the stores cards. These costs include invoice price purchasing department expense, transportation charges receiving storing, and handling expenses. Practical difficulties arise however, when attempt is made to charge these theoretical costs to inventory.

**Invoice Price**—The invoice price is determined by the vendor's invoice covering incoming materials. Trade discounts allowed by the seller are usually deducted from the invoice price before making entry. Cash discounts may or may not be deducted before the entry is made in the voucher register, depending upon the method of recording vouchers as described below. The entry made in the voucher register charging Raw Materials control must agree with entries made on the stores ledger card.

The War and Navy Department regulations concerning material costs on government contracts provide as follows:

The cost of materials parts and supplies should be limited to their net cost after deduction of benefits of any kind arising from such purchases received by or on behalf of the contractor including any benefits which were available to him but were not obtained by him, excepting only when he has been prevented from obtaining them by the fault or delay of the Government. The benefits referred to include:

- a All trade discounts rebates allowances credits commissions refunds, bonuses etc, arising from purchases of materials parts and supplies
- b Cash discounts on such purchases in excess of 1 percent and all cash discounts accruing to prime contractors on subcontracts

**Purchase Discounts**—There are different ways of entering purchase discounts in the voucher register. In this connection Dohi, Inghiam, and Love (Cost Accounting) state:

1. The total amount of the expenditure may be entered without deduction for the discount which may be secured by payment within a certain time. In this case the total of the Vouchers Payable column will be entered to the credit of the Vouchers Payable control account in the ledger (also known as "audited vouchers," "accounts payable," "due trade creditors," etc.) When the item is paid and the amount of discount deducted the net amount is entered in the cash disbursement journal (cash payments journal) and the amount of the discount is entered as a contra entry to the Vouchers Payable control account.

entered in a separate column and charged to an account called "Discounts Not Taken Advantage Of"

**Purchase Department Expense**—Expenses of the purchasing department include salaries and wages, stationery and supplies, light, heat, charge for space occupied, telephone, telegraph, postage, depreciation on equipment, etc. These expenses are logically a part of cost of materials and supplies, but cannot readily be assigned to particular lots or classes. The usual practice is to charge such costs to a special account and prorate them over the purchases on some appropriate basis. For example, a percentage relationship between total purchase department expense and total material purchases is predetermined, and this percentage is then applied to the invoiced cost of material to determine its share of buying expense.

In some cases purchase department expense may be charged directly to the material purchased. This is usually done by computing the average unit cost of purchase orders, i.e., dividing the total cost of purchasing for a given period by the number of orders issued during a period, and adding this average unit cost to each invoice. This additional cost must be shown in the Raw Materials control account and in the detailed stores records. The method is theoretically correct but almost impossible to use in practice, due to wide variations and complexities in purchasing procedure.

**Transportation Charges**—Transportation charges include freight express, trucking, parcel post, cartage, lightering and switching. In accounting for transportation charges, attention should be directed to the following points:

- 1 Who pays the freight vendor or buyer?
- 2 Is invoice price of material f.o.b. vendor's plant, with freight allowed at a standard rate?
- 3 Are some materials of the same kind bought f.o.b. purchasers and some f.o.b. vendor's plant?
- 4 Is some material received by express, some by boat, some by motor freight and some by rail? If so, what are the differences in rates?
- 5 Is material received in carload lots or less than carload lots?

Incoming and outgoing freight charges are classified for voucher register purposes by Dohr, Inghiam, and Love (Cost Accounting) as follows:

- 1 Freight to be deducted. Where the vendor is to pay freight it often happens that freight is actually paid to the railway or express company by the vendee and deducted from the invoice in making payment. When freight is paid it may be charged to the vendor's account through the voucher register or charged to an account called "Freight to Be Deducted" which is later credited and the vendor's account charged when payment of the invoice in question is made. This situation arises when goods are purchased f.o.b. the vendor's factory with freight allowed.
- 2 Where the vendee pays the freight the amount is added to the Raw Materials column of the voucher register and charged to the control account of Raw Materials. In this case the amount of freight must be reported to the balance of stores cleared for entry on the raw materials stores cards. The unit cost of materials in this case will be the invoice price, less cash and trade discounts plus freight express and cartage charges.
- 3 Freight and cartage charges in connection with other incoming ship-

ments will be added to the expense account to which the cost of materials is added or which is to bear the cost. Thus freight on incoming samples which have been used by salesmen as a selling expense and should be so charged.

4 Outgoing freight on purchase returns will be charged to the vendor if goods are returned because of his fault but will be included in Miscellaneous Freight account if they are to be borne by the company returning goods.

Concerning inward transportation charges on government contracts the War and Navy Departments state

Incoming transportation charges are a proper part of material cost. If they are not so treated in the accounts of the contractor their inclusion elsewhere should be on an equitable basis of apportionment.

All transportation charges on inward-bound materials and supplies used in production are debited to the perpetual inventory records and Stores control account when possible. Where this is not possible transportation charges may have to be allocated. Thus, transportation charges may be accounted for in different ways, some of which are as follows:

- 1 Charged to Stores or Raw Materials control and recorded on individual stores cards.
- 2 Charged to manufacturing expenses as indirect expense instead of a part of material cost. This involves subsequent proration.
- 3 Charged to Transportation In account and distributed to production costs as materials are issued and used.

When possible, transportation costs on goods purchased are charged to Raw Materials control in the general ledger and to individual material accounts in stores ledger. If the goods received consist of one kind only, the cost per unit is obtained by dividing the invoice price plus transportation charges by the number of units received. If the incoming shipment is made up of more than one kind of material, transportation costs must be allocated to the various kinds on a basis of weight, or bulk, or both, the procedure from this point on is similar to that when only one kind is received. The combined invoice and transportation costs must be entered on stores cards in the Received and Balance sections, and computations must be made to determine the unit price to be used in charging out material.

**Transportation Charges as Overhead**—It is because of such practical difficulties just described that some concerns charge transportation costs on incoming material to manufacturing expense or burden and distribute the latter to production as an indirect expense, usually on the basis of quantity or cost of material used. Bennett (N.A.C.A. Year Book, 1940) suggested that, except in the case of bulk goods such as coal, pig iron, steel, etc., inward transportation charges on raw materials should be treated as a part of operating burden rather than included in the inventory value of raw material. The discussion which developed on this point indicated that most industrial accountants feel that transportation costs are a logical and necessary part of the cost of raw materials. As a general rule, some of the other costs connected with purchasing, receiving, storing, disbursing, and accounting for materials are not added to their cost, but are absorbed in production by inclusion in



general overhead. Although this method is not correct in theory, and should not be used when it can be avoided, still it is a practical way of handling difficult situations.

Another method of handling transportation costs on purchases used by a few concerns is to charge a **Transportation In** account and then distribute to work in process or cost of production as materials are issued and used. **Transportation-In** account under this method is treated as a deferred asset. Transportation costs are prorated to production on some appropriate basis, usually weight, or bulk, or both. Obviously, this method cannot be used successfully under all situations. It also raises the question of the disposition of over- and underabsorbed balances in the **Transportation-In** account.

**Materials Handling Charges**—Receiving, storing, and handling expenses are logically part of the cost of materials and supplies, and when possible should be reflected in the cost shown on perpetual inventory records. Due to the fact, however, that such costs cannot readily be assigned to particular lots or classes, the standard practice in manufacturing is to charge such costs to a special burden account and distribute the latter to production on some appropriate basis.

Seeber (N. A. C. A. Year Book 1937) describes the use of a material burden rate where a portion of the expenses of the purchasing and receiving departments, the expense of maintaining stockrooms and stock room records and various other expenses relating to materials are accumulated and applied to production as a material burden on a weight basis. Another example of the use of a material burden rate is found in the Uniform Accounting Manual for the Rubber Manufacturing Industry from which the following is quoted:

All general expenses and nonproductive departmental expenses which are incurred in connection with the purchasing, receiving and handling of materials should be apportioned directly to the cost of materials or supplies on the basis of deliveries of materials and supplies from stores into process during the period under two specific methods as explained later. The expenses or overhead which should be applied to material cost will consist of the following:

Purchasing Department  
Receiving Department  
Stores Department  
Invoice Auditing Department  
Traffic Department (incoming materials)  
Material Testing Department

All expenses incident to the functions of these departments should be collected under departmental classifications outlined above, and for accounting purposes should be debited to an account instituted to collect all these material handling charges known as **Cost of Receiving and Handling Materials**. These expenses should be recovered in cost as an addition to the cost of all material by either of two methods as follows:

1. Material handling costs for the major materials such as rubber, reclaimed rubber, other compounding materials and textiles, should be recovered in cost on a tonnage basis.
2. The material handling expenses for all other materials and supplies should be recovered in cost on a value basis.

The Research and Service Department of the National Association of Cost Accountants (N A C A Bulletin vol 18) received replies from 197 companies in answer to the question "What costs (other than invoice price) do you include in inventory value of raw materials?" These replies show that a large majority of reporting companies include freight and cartage-in as part of cost of raw materials, and that other costs such as purchasing, receiving, and storing are not included. The replies are tabulated below:

Item	No of Companies Including	Per Cent of Total Companies Reporting
Freight and cartage in	180	91.4%
Receiving and storing expense	25	12.8
Purchasing department expense	7	3.6
Unloading expense	4	2.0
Interest on borrowed capital	2	1.0
Allowance for shrinkage	2	1.0
Container cost	1	.5
Sampling and laboratory expense	1	.5

It must be understood that use of a material burden rate to absorb indirect costs of raw material is the exception rather than the rule. In some industries where one or a few raw materials are used, there may exist some logical basis, such as weight, on which these costs may be absorbed as a part of material costs. But more commonly, a logical basis for such application does not exist with the result that these indirect costs relating to material are combined with other indirect costs and absorbed through the application of departmental burden rates. The test, as in all cases involving cost classifications, is the test of greatest accuracy at reasonable cost.



## SECTION 13

### MATERIAL COSTS AND INVENTORIES

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ments based on different inven-		balance sheet	732
tory valuations ( <i>f 25</i> )	721		

## SECTION 13

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### MATERIAL COSTS AND INVENTORIES

#### Materials and Supplies Issues

**FORMS AND RECORDS**—To keep the stock records in agreement with the physical units on hand, and to account accurately for all items that go out of the storesroom, it is essential that no materials leave the storesroom without proper authorization and without a proper record being made. As materials are withdrawn from stockrooms a written authority is presented to the stores clerk, either in the form of a bill of materials or a requisition. These forms supply the data for charges to production and credits to material accounts.

The forms and records used to account for the issue of materials are

- 1 Stores requisition
- 2 Bill of material
- 3 Materials and supplies requisition record
- 4 Subsidiary ledgers
  - a Stores ledger
  - b Cost ledger

**Stores Requisition**—This is a written order drawn on storeskeeper to deliver certain materials and supplies for use in the factory. It is usually prepared by the production department although other departments may be given authority to requisition materials and supplies when required. The essential information found on a stores requisition is shown in Figs 1 and 2.

No requisition should call for materials to be used on more than one production or standing order, since each requisition must be filed with its respective cost sheet or department. Furthermore, one requisition should not be used to get material from more than one storesroom, since each storeskeeper is required to show receipts for the issuance of material.

The number of copies made of a stores requisition depends upon the accounting system in use. In most plants at least two copies are needed, one being kept on file by the issuing department, the other being presented to the storeskeeper and then sent on to the stores ledger clerk and the cost clerk.

Fig 1 is prepared by an authorized person such as a superintendent foreman or department manager. The requisition is made in triplicate, the original going to the storesroom. The duplicate is retained in the originating department as a follow-up. The triplicate is sent to the stores ledger bookkeeper as the posting medium for all issues. When materials



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are issued, entries for quantities only are made on the bin or perpetual inventory tags (Fig 11) Columns on Figs 1 and 2 for unit cost and total cost are left blank to be filled in later by the ledger clerk. When the latter gets the requisition from the storekeeper, he writes in the prices of materials records the data in the Issued and Balance sections of the appropriate stores cards, and enters the proper information on a materials and supplies requisition record (Fig 4). The stores ledger clerk sends the priced requisition to the cost clerk, who enters the data on the proper standing or production order keeping the copy on file in the cost department. Sometimes three copies of the requisition are made, one copy (not priced) being kept by issuing department, the second copy (still not priced) being retained by the storekeeper as a receipt for the issuance of the material, and the third copy being sent to the stores ledger clerk for pricing and entry on the stores records, and thence to the cost clerk for entry on the cost records.

**Bill of Material**—There has always been objection to the duplication involved in the use of requisitions for direct materials. Many companies now use a bill of material (Fig 3). This is a detailed list of various materials required for a given job and is drawn up by the engineering or planning department, usually in blueprint form. When a bill of material is used in lieu of stores requisitions a copy goes to the factory along with production order. The store room is also furnished a copy of the bill of material which therefore acts as authority to the storekeeper to issue the required materials. Often the bill of material is made up in such a manner that it can be split up by departments, so that the store room issues the required materials to each department at the proper time.

MATERIAL AND SUPPLIES REQUISITION RECORD								
DATE	REQ NO	JOB OR ACCOUNT NO	DESCRIPTION	DEBITS				CREDIT
				MATERIAL IN PROCESS	MFG EXPENSE	SUNDRY ACCOUNTS		RAW MATERIAL CONTROL
						ACCT NO	AMOUNT	

FIG 4 Materials and Supplies Requisition Record

**Materials and Supplies Requisition Record**—After the posting and pricing of requisitions is completed, they are sorted and entered in the appropriate column on a material and supplies requisition record which is a summary of materials consumed. Requisitions may be entered individually, or in summary from adding machine lists, depending upon the number of requisitions to be handled. This record is illustrated in

Fig 4 Posting to the general ledger or factory ledger may be made directly from this record, or it may be summarized in the journal as follows

Material in Process	\$
Manufacturing Expense	
Sundry Accounts (posted in detail)	
Raw Material	\$

**Subsidiary Ledgers for Issued Materials and Supplies**—Two subsidiary ledgers are used when materials and supplies are issued, namely, the stores ledger controlled by the Stores account and the cost ledger controlled by Material in Process. When materials and supplies are requisitioned from stores, entries must be made on the appropriate stores ledger sheets or cards in the Issued and Balance sections by the stores ledger clerk. The following information is usually entered in the Issued section: date, requisition number, production order number, quantity, unit cost, and total value. Quantity and value issued are then deducted in the Balance section, resulting in a balance on hand which is recorded as to quantity and total value. The sum of these balances on the various stores ledger cards should equal the balance in the Stores control account. Unit and total value columns are often omitted both in the Issued and On Hand sections of the card. This is particularly the case where standard costs are used, in the latter event, requisitions are usually priced at Standard and actual costs summarized only once a period.

The cost ledger clerk then makes the proper entries for requisitions of materials on job order cost sheets. These entries are made in the Materials section of the cost sheet. Where a great number of requisitions are to be accounted for, they are often summarized before entries are made on cost sheets. This is done so that the total material costs for any one job or order may be accumulated on one cost sheet. A convenient method is to have a cost sheet jacket with pertinent information appearing on outside and cost sheet and documents relating to costs of the order being accumulated inside the jacket for periodic posting to the cost sheet. Another method is to use some device for sorting requisitions by jobs or processes or in any other classification desired. The use of tabulating equipment in determining and controlling material costs is presented later in this Section.

**MATERIALS AND SUPPLIES RETURNED FROM FACTORY TO STORESROOM**—Sometimes more materials and supplies are requisitioned for use in the factory than are needed. This excess is returned to the storesroom. In accounting for such returns three copies of a materials and supplies credit or return slip (Fig 5) usually are filled out. One copy is retained by the foreman or department returning the goods, one copy is sent to the storeskeeper and the third copy is used by the stores ledger clerk and cost clerk for accounting purposes. The storeskeeper receipts the foreman's copy after receiving the returned materials, and makes entries from his copy on proper bin tags. The copy sent to the stores ledger clerk is priced by him and entries are made on appropriate stores cards, as well as in a record of returns to the storesroom. When the cost clerk receives the copy of return slip, he records the amount of the return on the proper production or standing order.

RETURNED STORES		DATE _____		ORDER _____	
QUAN	DESCRIPTION OF MATERIAL	DRAWING NO	QTY	COST	
		BAL			
		BAL			
		BAL			
ENTERED ON STORE CARDS				TOTAL	
SIGNATURE OF PERSON RETURNING MATERIAL		MAKER'S RECORD			
		DATE	BY		

FIG 5 Returned Stores Slip

The stores ledger clerk may enter the **return slips** in the received section of the stores cards, or entered in the Issued section. In each case the quantity and value of the return must be added to the quantity and value shown in the Balance section. In addition, the return slips are sorted and entered in the appropriate column on a **summary of returns** to the storesroom (Fig 6). These slips may be entered individually, or summarized from adding machine lists depending upon the

SUMMARY OF RETURNS TO STORESROOM								
DATE	RETURN SLIP NO	JOB OR ACCOUNT NO	DESCRIPTION	DEBIT	CREDITS			
				STORES	MATERIAL IN PROCESS	MFG EXPENSE	SUMMARY ACCOUNTS	
							ACCOUNT NO	LF AMOUNT

FIG 6 Summary of Returns to Storesroom

number to be handled. Posting to the general or factory ledger accounts may be made directly from this record, or a summary may be made in the journal as follows:

Stores	\$	
Material in Process		\$
Manufacturing Expense		
Sundry Accounts (posted in detail)		

**REPORTS ON SUBSTITUTIONS AND ADDITIONAL MATERIALS**—If it is necessary to substitute one kind of material for another where material requisitions are in use, most companies require a returned material slip to be used to return for credit the material drawn from stock. A new requisition is then issued to withdraw new material from stock.

When additional materials are required to complete an order after the proper material requirements have been met, the customary practice is to require approval of some person higher in authority than the person authorized to withdraw the original materials. By making approval of additional material requisitions mandatory, an automatic control is established against carelessness in production. Specific reasons are required for withdrawing additional materials, such as defective stock, workman's error, defective tools or dies and the like. If defective stock is the cause, a report covering the defect in question is filed.

When bills of material are in use, substitutions of materials are recorded on the bill of material and all copies issued must carry the sub-

TO: ENGINEERING DEPT. CHIEF INSPECTOR MFG. & MNT. ST. PRODUCTION DEPT. STOCKS & SUPPLIES FACTORY MANAGER ACCOUNTING	<b>MATERIAL SUBSTITUTION AUTHORITY</b>	DATE _____
PART NO. _____		
PART NAME _____		
ON ORDERS _____		
FOR _____ THE FOLLOWING MATERIAL MAY BE USED _____		
REMARKS _____		
AUTHORIZED BY _____ APPROVED REQUEST OF _____ DATE _____		
SIGNED _____		

Fig 7 Material Substitution Authority

stitution. In most companies, substitutions are approved by the engineering department (Fig. 7). When additional materials to those listed on the bill of material are required, approval is secured from designated persons in charge.

**SUPPLIES USED AS RAW MATERIAL**—As a general rule, there is a definite line between materials purchased for production and materials purchased for supplies. Materials purchased for production are often segregated from materials purchased for supplies. In such cases control accounts are established in the general ledger for "Raw Materials" or "Direct Stores," or similar title to record direct materials. Indirect materials or supplies are recorded in separate control accounts. Withdrawal of direct materials is distinguished from withdrawal of indirect materials by the use of different forms and different colors of requisitions. If materials ordinarily used as direct materials are withdrawn for use as indirect materials, an indirect material requisition is used. On the other hand if materials ordinarily classified as indirect are withdrawn for use on production orders, a direct material requisition is used. Direct material requisition numbers are run as a separate series and are readily distinguished from the serial numbers used to identify indirect material requisitions.

## Storing

**NATURE OF PROBLEM**—The problem of storing is of interest to the production engineer and also to the cost accountant since it is an important feature in inventory control. From the cost accountant's viewpoint the problem, according to Dohr, Inghram, and Love (*Cost Accounting*), resolves itself into

- 1 Organization of stores department
- 2 Identification of stores
- 3 Classification and symbolization

**Organization of Stores Department**—The stores department is headed by a general storekeeper, whose duty it is to supervise its work. Requests for purchases are initiated here, and are approved by the storekeeper before being forwarded to the purchasing department. When goods are received, the receiving and inspection reports should have the storekeeper's approval before being forwarded to other departments. The section operating the stores ledger is, in many modern installations, made a part of the storekeeping function. In some plants the stores ledger clerks are attached to the cost department, the planning department, and even the purchasing department. It is through the stores ledger clerk that the storekeeper gets much basic information required for the efficient administration of the stores department.

After goods have been received and unpacked, and the necessary reports made out, the materials must be stored and cared for.

- 1 Materials must be identified and labeled so that there is no doubt as to their nature or identity
- 2 Proper kind of storage space must be provided so that materials are not injured in storage. This includes a consideration of the proper

- Kind of bin, rack or shelf proper temperature, ventilation lighting, dryness and proper kind of fire protection in the case of inflammable materials
- 3 Materials must be recorded and located so that they can be easily found and issued when wanted In order to accomplish these things it is necessary to develop well defined methods of storage with which storesroom employees are familiar and in accordance with which all materials will be stored

In order to handle raw materials efficiently, it is essential to locate the storesrooms at such a place or places that they may best serve the various departments using goods, and also be in a position to receive goods conveniently on arrival The storesrooms are therefore located with a view to

- 1 Facilitating the issue of materials by their nearness to the place where materials are used
- 2 Facilitating the receiving and shipping of materials by proximity to shipping facilities
- 3 Obtaining proper kind of storage conditions considering the nature of the goods stored

**Identification of Stores**—Every item of materials handled should have a definite name and should always be dealt with under that name In storing every lot unit, or article should be marked or labeled so that it can be identified in the storesroom without breaking the container or wrapper in which the goods are packed In addition to the identification of the goods themselves, there should be a plan of identification carried out in all parts of the storesroom by the following methods

- 1 The storesroom is sectionalized and only goods of one particular class stored in each section In order to identify sections signs are suspended from the ceiling in each section indicating the general character of goods stored in that section
- 2 Signs indicating the general class of goods stored on the aisles are suspended over the aisles printed on the aisle bin or shelf, or painted on the aisle floor
- 3 Signs or tags are placed on all bins racks pans shelves etc to indicate the particular materials stored therein
- 4 Floor plans should be posted in various parts of storesroom indicating various storesroom sections and the general class of goods stored therein
- 5 Finding lists should be prepared showing the various sections aisles and storage spaces of the storesroom and class of goods stored in each

If this process of identification is carried out the location of goods is standardized and the process of storing is facilitated This is particularly true in the case of new employees in the stores department, with proper identification methods new men are able to find any article in the storesroom after a brief experience

**Classification and Symbolization**—The problem of identification requires the assignment of a definite name to each item stored In addition to the name it is advantageous to assign a number or symbol to each item, since it is easier to use symbols in place of names The sym-

bol being shorter considerable time and effort may be saved by substitution of a symbol for the longer and more cumbersome name. Development and use of a scientific system of symbols contributes greatly to the efficient handling of and accounting for stores.

The process of symbolization and classification involves two steps:

- 1 Analysis of the various items of stores in order to determine how many items there are and the exact nature of each. After analysis an appropriate name is selected for each item.
- 2 Regrouping of the analyzed items into smaller groups on the basis of certain similarities or relationships and assigning a name to each group. Smaller groups are then placed into larger groups to which a name is assigned. This process is continued until all items appear in a few major groups.

A good system of symbolization should have the following characteristics:

- |                |                 |
|----------------|-----------------|
| 1 Simplicity   | 4 Aid to memory |
| 2 Definiteness | 5 Elasticity    |
| 3 Brevity      |                 |

Simple code systems are more easily learned by storesroom employees. At the same time each symbol must be definite without the possibility of confusion. Code symbols employed should be as brief as possible and be so arranged that the classification is easily remembered. Finally the system should provide for changes, additions, etc.

**SYSTEMS OF STORES SYMBOLIZATION**—Various schemes of symbolization are in practical use in industry. The chief methods are:

- |              |                   |
|--------------|-------------------|
| 1 Alphabetic | 4 Sign and signal |
| 2 Numeric    | 5 Mixed           |
| 3 Mnemonic   |                   |

In an alphabetic code, letters are arbitrarily chosen to represent particular accounts or classifications. The same is true of the numerical systems, except that numbers are substituted in place of letters. A special type of numeric classification is the decimal system. Here numbers are assigned in such a manner that each digit represents a subgroup or subaccount of the previous digit.

Mnemonic symbols consist of letters whose sound suggests the word or account designated. (For detailed presentation of these various systems of coding see Section 3.)

**Decimal and Mnemonic Systems**—An application of the decimal and mnemonic systems to stores is made by Dohi, Inghram, and Love (Cost Accounting) as follows:

All symbols used for stores will begin with the letter S to indicate the stores department. In the storesroom the basic classification might appear as follows:

	Decimal	Mnemonic
Foundry	91	SP
Special stores for job work	92	SJ
Machine parts	93	SM
Pattern shop	94	SP
Repair parts	95	SR
General classified	96	SV

The general classified stores would then be symbolized as follows all symbols beginning with 96 or SV as the case may be

	Decimal	Mnemonic
Chemicals	961	SV-C
Hardware	962	SV-H
Ink and inking materials	963	SV-K
Lumber	964	SV-L
Paper	965	SV-P
Steel	966	SV-S

In each classification the remaining numbers not assigned may be used for additional items when required. It will be noted in connection with the decimal system that only ten groups are available, while in the case of the mnemonic there are 26 possible subdivisions in each case. Each of the groups above will be further subdivided it being customary at this point to insert a period in the decimal symbol in order to make it easier to read. The group for inks would be further subdivided as follows

	Decimal	Mnemonic
Black	963 1	SV-KB
Green	963 2	SV-KG
Brown	963 3	SV-KN
Pink	963 4	SV-KP
Red	963 5	SV-KR
Blue	963 6	SV-KU
White	963 7	SV-KW
Yellow	963 8	SV-KY

If there are various grades or sizes of any classification such grades or sizes may be indicated in the symbol by the use of numbers. Thus black inks of various grades above could be indicated as follows

	Decimal	Mnemonic
Grade 1	963 11	SV-K1B
Grade 2	963 12	SV-K2B
Grade 3	963 13	SV-K3B
Grade 4	963 14	SV-K4B
Grade 5	963 15	SV-K5B

The foregoing method classifies materials according to their nature and is in general use. It is advisable for classification of stores where there is a wide variety of products and activities.

**Translation Charts**—Another method of stores classification makes use of translation charts, which classify materials according to use. This is much simpler than the other and leads to briefer symbols. Classification according to use utilizes a stores translation chart such as that shown in Fig 8 (Mgt Eng, vol 2) taken from Thompson and Lichtner. The basic classification is as follows

- SA - Office supplies
- SB - Brass and brass products including pipe and fittings
- SC - Coal coke and other fuels
- SD - Wood and wood products
- SE - Electrical supplies
- SF - Fastenings, bolts, nuts, nails, screws etc
- SG - Gaskets and packing



	A	B	C	D	E	F	G	H	J	K
8A Office supplies			Card ruled	Adhesive				Charts recording		
8B Brass bronze and pipes			Brass rollers							Screens
8C Coal coke fuel			Coke			Feed and coal		Hard coal		
8D Belts hose yoke and twine	Absorbent cotton	Belts	Good and rope			Felt	Belt and hooks & fasteners			Wicks
8E Electrical supplies	Tape	Batteries	Conduit and fittings		Bells and buttons	Fuses and fittings	Lamp guards	Shades and holders	Plugs	Knobs and terminals
8F Fastenings bolts and screws		Belts	Cutter pins	Wood screws		Nails and spikes	Lag screws			Cap screws
8G Oars		Bakelite plaques								
8H Hangers pulleys and clutches		Bushings	Collars					Hangers		Brackets
8J Gaskets packing							Gaskets			Gaskets
8K Chemicals			Carbonate of soda			Formic acid				Caustic
8L Liquids lubricants and paints	Shellac	Belt dressing	Cement linoleum	Paints in powder	Lansed oil		Greases			
8M Engine boiler power										
8N										
8P Iron pipes and fittings	Caps	Bushings	Couplings	Bends	Elbs	Flanges	Tubing	Dip-holders	Sprinkler fittings	Dips and seals
8R										
8S Steel iron	Angle iron	Bar iron	Steel channel	Galvnd channel	Tea iron		Galvnd steel		Wheels	Cables
8T Tools implements supplies	Taps and dies	Brushes and supplies	Con tainers	Drills and reamers	Screw drivers	Files	Glass supplies	Hammers		Knives
8U Building materials		Bricks	Cement			Plaster Fiber	Gravel			
8V Abrasives			Carborundum							
8W Wood		Bungs	Chestnut		Cypress	Fiber board		Sticks		Oak
8X Otherwise unclassified			Copper finishing			Flints		Hooks		
8Y Other metals		Babbitt metals								
8Z Special parts and equipment				Dry screens			Grinding mills			

FIG 8 Stores Translation Chart

L	M	N	P	R	S	T	U	V	W	X	Y	Z
			Paper	Printed forms	Shams	Toilet supplies						
			Pipe fittings		Stock				Brass sps wire			
				Charcoal	Black Coal							
Leather		Lining			Moos	Textile fabrics		Pipe cover ing	Waste and rags			
Lamps	Motors and motors			Rosettes	Sockets	Tele- phone material	Bells and eyes		Wire	Supplies	Solder, wire and paste	
Expense sheets	Machine screws	Nuts	Staples	Rivets	Set screws	Fasten ers	Draw pins		Washers	Tacks	Studs	Snaps
	Mitre gears	Meter plates			Spar gears							
Clutches			Pulleys	Bearings								
			Packing									
Lime	Muriatic acid			Carbon tetr, chloride	Salt		Sulphur					
Lubri- cants oils		Turpen- tine	Paints in oil	Dryer	Lubri- cants solid	Petro- leum prod sals	Petty	Varnish				
Pipe plug	Rams	Nipples nozzles	Pipe	Rail fittings	Crosses and joints	Tees	Unions	Valves	Valve wheels	Cock		Faucets
	Machine steel	Screws		C R steel	Sheets	Tool steel			Wire		Sprocket	Chain
Handlin	Boxes and drawers	Cutters	Punches	Forks	Saws			Shovels	Trenches			
					Sand		Quartz					
Oxide												
	Maple			Hickory	Spruce				Walnut		Mahog- any	
			Plaster of paris	•			Blue chalk					
Lead	Monel metal				Pushing stock		Alum- inum					zinc
			Pump parts	Elevator parts	Steam traps			Valves	Welding materials			

(Thompson and Lechtner)

- SH - Hangers stands boxes bushings pulleys and clutches  
 SJ - Goods made of all materials  
 SK - Chemicals and pigments  
 SL - Liquids lubricants oils gasoline and paints  
 SM - Machine and engine parts for boiler power and water supply  
 SN - Metals not otherwise classified as Babbitt lead zinc etc  
 SP - Pipe pipe fittings, and tubings made from cast iron wrought iron and steel  
 SR - Rubber scrap  
 SS - Steel wrought or cast iron, and products made chiefly from same  
 ST - Tools implements and supplies  
 SU - Building materials such as cement quartz sand and brick  
 SV - Abrasive, emery wheels grindstones etc  
 SW - Wearing apparel  
 SX - Stores not otherwise classified  
 SY - Fibrous and textile materials—belts and sundries hose rope and twine  
 SZ - Special parts and supplies for equipment

Use of the above classification to formulate individual account symbols based on the translation chart is shown in Fig 9. The symbol for any particular item is obtained by combining the symbol letters at the left of Fig 8 with any particular letter at the top. Thus the symbol for electric lamp sockets is SES, i.e., SE (Electrical Supplies) S (Sockets) and symbol for brass electric lamp sockets is SESB, i.e. SES (Electric Lamp Sockets), B (Brass)

SLSA	SESP - Porcelain key
SESB - Brass key sockets	SES1P - Small
SES1B - Small	SES2P - Large
SES2B - Large	SESR - Porcelain keyless
SESC - Brass keyless sockets	SES1k - Small
SES1C - Small	SES2R - Large
SES2C - Large	SESS - Porcelain pull
SESE	SES1S - Small
SESF	SES2S - Large
SESG	SEST - Street hood socket
SESH - Hood forks	SESU
SESJ	SESV
SESK - Socket forks	SESW
ESL	SESX
ESM - Mica sockets	ESY
ESN	ESZ

FIG 9 Functional Parts Coding (based on translation chart)

**CLASSIFICATION FOR PARTS**—Numerical classifications are commonly adopted for parts of machines and manufacturing articles which must be assembled. Sometimes letters are combined making the system a combination of numerical and alphabetical. An example is Fig 10. In this diagrammatic arrangement each part is designated by a number, or a number and following letter and the way in which they are associated to help build up the subassemblies of the rifle and finally the rifle itself are shown. This was developed by Fred A. Waldron (Mgt. & Admin., vol 7)



**CLASSIFICATION OF MATERIALS AND SUPPLIES**—The system of classification of materials and supplies used by the Detroit Edison Co for its records and catalogs is given below (Am Standards Assn Bul, vol 3) The fundamentals upon which this classification is based are

- 1 Divisions should be specific enough to exclude all duplicate listing of items or ambiguity
- 2 Arrangement should be broad enough so that divisions will not be come so numerous as to be cumbersome

The method of classification adopted is to bring together like items wherever practicable Following this plan the main classes are selected by a building-up process in which groups of materials which appeared allied in nature, and distinctive enough to be set apart from other items, are assembled into a class This class is given a name distinctive of the materials it contained as "Valves" "Wiring supplies" "Bolts screws nails, rivets," "Packing and gaskets," "Glass and glazing materials" The sequence of these main classes after they had been determined upon is as follows

- Building materials and general hardware
- Mechanical equipment
- Electrical equipment
- Miscellaneous

Within these four general groupings the classes are arranged by placing kindred materials in close proximity to one another, but the broad groupings do not appear as a distinctive part of the classification The main classes of materials are arranged from a consideration of the degree of relationship existing between the material grouped in each sub division

The numbering system for the items is based on a seven-digit number The first two digits designate the main class of material in which the item belongs The third digit indicates the subclass and the last four digits comprise a serial number Thus, an item numbered 543-0341 would be in class 54 ("Valves") and in subclass 3 ("Globe valves") It is also the 341st item in that subclass This classification is in use by the accounting stores, purchasing, and other departments as a basis for their various records

#### Classification of Materials and Supplies

10 MASONRY AND CONCRETE MATERIAL	12 *
10 0 Cinders gravel sand crushed stone etc	13 LUMBER
10 1 Lime plaster and cements	13 0 Yard lumber
10 2 Brick terra cotta vitrified sewer pipe tile etc	13 1 Millwork (doors sash interior trim etc)
10 9 Miscellaneous masonry and concrete material	13 2 Timbers (ties switch timbers etc)
11 CUT AND ARTIFICIAL STONE	13 9 Miscellaneous lumber (shavings sawdust etc)
11 0 Marble	14 POLES CROSS ARMS, AND OTHER WOODEN LINE MATERIAL
11 1 Slate	14 0 Poles
11 2 Granite	14 1 Cross arms
11 3 Alberene	14 2 Other wooden line material
11 4 Artificial stone	
11 9 Miscellaneous stone	

\* Reserved for possible expansion of classification as need may arise in the future

## Classification of Materials and Supplies (Cont'd)

<p>15 BUILDING INSULATION AND LUMBER SUBSTITUTES</p> <p>15 0 Lintel, plaster and wall board</p> <p>15 1 Building and roofing papers</p> <p>15 2 Composition slungies etc</p> <p>15 9 Miscellaneous building insulation and lumber substitutes</p> <p>16 PAINTS AND OTHER PROTECTIVE COATINGS</p> <p>16 0 Prepared paints</p> <p>16 1 Paint ingredients</p> <p>16 2 Bronzing material</p> <p>16 3 Driers</p> <p>16 4 Fillers</p> <p>16 5 Thinners</p> <p>16 6 Shellac and varnish</p> <p>16 7 Lacquer and enamel</p> <p>16 8 Other protective coatings</p> <p>16 9 Miscellaneous protective coatings</p> <p>17 *</p> <p>18 GLASS AND GLAZING MATERIAL</p> <p>18 0 Clear sheet (window) glass</p> <p>18 1 Polished plate glass</p> <p>18 2 Obscure (tough) glass</p> <p>18 3 Wire glass</p> <p>18 4 Mirrors</p> <p>18 5 Glazing material</p> <p>18 9 Miscellaneous glass</p> <p>19 *</p> <p>20 BUILDERS HARDWARE</p> <p>20 0 Bars plates and rods</p> <p>20 1 Braces and brackets</p> <p>20 2 Hooks and holders</p> <p>20 3 Knobs handles and pulls</p> <p>20 4 Bolts catches and latches</p> <p>20 5 Locks and padlocks</p> <p>20 6 Door checks springs and stops</p> <p>20 7 Hinges and door hangers</p> <p>20 9 Miscellaneous builders hardware</p> <p>21 *</p> <p>22 &amp; 23 GENERAL HARDWARE</p> <p>22 0 Abrasives</p> <p>22 1 Carts wagons wheelbarrows push trucks etc</p> <p>22 2 Furniture shoes casters cart wheels etc</p> <p>22 3 Containers (funnels mea ures buckets barrels cans pots kettles etc)</p> <p>22 4 Fencing</p> <p>22 5 Hose, hose fittings and rubber tubing</p> <p>22 6 Ladders staging scaffolds etc</p> <p>22 7 Lanterns flashlights and torches</p> <p>22 8 Lubricating equipment</p> <p>22 9 Welding and soldering equipment</p> <p>23 1 Pipe hangers and straps</p> <p>23 2 Fittings for wire rope and chain</p> <p>23 3 Springs</p> <p>23 9 Miscellaneous general hardware</p>	<p>24 LINE HARDWARE</p> <p>24 0 (Alphabetical arrangement)</p> <p>25 LOTS SCREWS NAILS RIVETS ETC</p> <p>25 0 Anchors shields etc</p> <p>25 1 Bolts</p> <p>25 2 Nuts</p> <p>25 3 Cotters washers etc</p> <p>25 4 Brads nails spikes etc</p> <p>25 5 Screws screw eyes and screw hooks</p> <p>25 6 Rivets</p> <p>25 9 Miscellaneous fasteners</p> <p>26 *</p> <p>27 TOOLS (HAND AND MACHINE)</p> <p>27 0 (Alphabetical arrangement)</p> <p>28 *</p> <p>29 *</p> <p>30 IRON AND STEEL</p> <p>30 0 Rolled shapes and other hot rolled sections</p> <p>30 1 Concrete reinforcing steel and supports</p> <p>30 2 Iron and steel wire</p> <p>30 3 Tool steel and special iron and steel</p> <p>30 4 Fabricated structural steel</p> <p>30 5 Fabricated structural steel for towers and outdoor substations</p> <p>30 6 Fabricated ornamental work</p> <p>30 7 Fabricated sheet steel</p> <p>30 8 Fabricated plate work</p> <p>30 9 Tanks and stacks</p> <p>31 *</p> <p>32 NON-FERROUS METALS (ALUMINUM BRASS ETC)</p> <p>32 0 Aluminum</p> <p>32 1 Brass</p> <p>32 2 Bronze</p> <p>32 3 Copper</p> <p>32 4 Lead</p> <p>32 9 Miscellaneous metals (zinc nickel monel etc.)</p> <p>33 CASTINGS</p> <p>33 0 Aluminum castings</p> <p>33 1 Brass castings</p> <p>33 2 Bronze castings</p> <p>33 3 Copper castings</p> <p>33 4 Iron castings</p> <p>33 5 Steel castings</p> <p>33 9 Miscellaneous castings</p> <p>34 *</p> <p>35 BUILDING SERVICE EQUIPMENT</p> <p>35 0 Building heating equipment</p> <p>35 1 Refuse burners</p>
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\* Reserved for possible expansion of classification as need may arise in the future

## Classification of Materials and Supplies (Cont'd)

35 2 Refrigerating equipment	45 2 Steam engines
35 3 Water coolers	45 3 Internal combustion engines
35 9 Miscellaneous building service equipment	45 4 Water wheels
36 CHAIN ROPE CORD ETC	46 CONDENSERS EVAPORATORS HEATERS AND WATER PURIFIERS
36 0 Chain	46 0 Condensers
36 1 Wire rope (wire cable)	46 1 Evaporators
36 2 Fiber rope (manila sisal etc)	46 2 Water heaters
36 3 Cord twine string, etc	46 3 Water purifiers
36 9 Miscellaneous chain and rope	47 PUMPS AND COMPRESSORS
37 *	47 0 Pumps
38 HOISTING MACHINERY AND EQUIPMENT	47 1 Air and gas compressors
38 0 Platform elevators	48 *
38 1 Cranes	49 AIR AND FLUE GAS CLEANING AND HANDLING APPARATUS
38 2 Hand hoists	49 0 Air filters and supplies
38 3 Power hoists	49 1 Air washers coolers, and humidifiers
38 4 Hoisting equipment	49 2 Fans
38 9 Miscellaneous hoisting machinery	49 3 Air heaters
39 MECHANICAL POWER TRANSMISSION EQUIPMENT	49 4 Dust collectors precipitators etc
39 0 Belting and accessories	49 9 Miscellaneous air and flue gas apparatus
39 1 Pulleys	50 OIL SEPARATORS RECLAIMERS COOLERS ETC
39 2 Bearings bushings boxes hangers etc	50 0 Oil separators
39 3 Couplings clutches and collars	50 1 Oil reclaimers and purifiers
39 4 Drives drive chains and sprockets	50 2 Oil filters
39 5 Gears	50 3 Oil coolers
39 9 Miscellaneous mechanical power transmission equipment	50 4 Oil apparatus accessories
40 *	50 9 Miscellaneous oil apparatus
41 CONVEYING AND TRENCHING MACHINERY AND EQUIPMENT	51 PIPE AND TUBING (INCLUDING SOIL PIPE)
41 0 Gravity conveyors	51 0 Steel pipe and tubing
41 1 Continuous conveyors	51 1 Wrought iron pipe
41 2 Jet and pneumatic conveyors	51 2 Cast iron pipe
41 3 Miscellaneous conveyors	51 3 Copper pipe and tubing
41 4 Conveyor equipment	51 4 Brass pipe and tubing
41 5 Trenching machinery and equipment	51 5 Lead pipe
42 *	51 6 Aluminum pipe and tubing
43 STOKERS BURNERS AND COAL PREPARATION EQUIPMENT	51 9 Miscellaneous pipe
43 0 Burners	52 PIPE FITTINGS
43 1 Stokers	52 0 Pressure fittings
43 2 Coal breakers crushers pulverizers, etc	52 1 Drainage fittings
44 BOILERS ECONOMIZERS SUPERHEATERS AND AIR PREHEATERS	52 2 Soil pipe fittings
44 0 Boilers	52 3 Railing fittings
44 1 Economizers	52 4 Pipe flange fittings
44 2 Superheaters	53 *
44 3 Air preheaters	54 VALVES
45 PRIME MOVERS (INCLUDING CONNECTED GENERATORS)	54 0 Angle valves
45 0 Turbo generator units	54 1 Check nonreturn, and stop check valves
45 1 Turbines	54 2 Gate valves
	54 3 Globe valves
	54 4 Safety relief valves
	54 5 Float foot and regulator valves
	54 6 Check (plug) valves
	54 9 Miscellaneous valves

\* Reserved for possible expansion of classification as need may arise in the future

## Classification of Materials and Supplies (Cont'd)

55 PIPING SPECIALTIES AND PLUMBING FIXTURES 55 0 (Alphabetical arrangement)	64 ELECTRICITY METERS 64 0 Watthour meters 64 1 Demand meters
56 PACKING AND GASKETS 56 0 Rod shaft and valve stem packing 56 1 Sheet packing 56 2 Gaskets 56 0 Miscellaneous packing	65 MOTORS GENERATORS AND CONTROLS 65 0 Motors 65 1 Generators 65 2 Motor generator sets rotary con- verters, etc. 65 3 Carbon brushes 65 4 Control equipment
57 *	66 TRANSFORMERS, REGULATORS AND RE- ACTORS 66 0 Power transformers 66 1 Distribution transformers 66 2 Street lighting transformers 66 3 Instrument transformers 66 4 Induction voltage regulators 66 5 Reactors 66 6 Capacitors (static condensers) 66 9 Miscellaneous transformers and regulators
58 HEAT INSULATION 58 0 Asbestos 58 1 Cork 58 2 Hair and wool 58 3 Mineral 58 4 Insulating cements 58 0 Miscellaneous heat insulation	67 *
59 REFRACTORIES (FIRE BRICK FIRE CLAY etc.) 59 0 Fire brick 59 1 Fire clay 59 2 Refractory cements 59 0 Miscellaneous refractories	68 CIRCUIT BREAKERS SWITCHES RELAYS AND JUMPERS 68 0 Oil circuit breakers 68 1 Air circuit breakers (carbon break) 68 2 Knife type switches 68 3 Safety switches 68 4 Control switches 68 5 Household switches 68 6 Relays 68 7 Jumpers plugs and jumper plug receptacles 68 9 Miscellaneous switches
60 MECHANICAL CONTROL APPARATUS 60 0 Temperature controls 60 1 Pressure controls 60 2 Volume controls 60 3 Speed controls 60 9 Miscellaneous mechanical control apparatus	69 *
61 MECHANICAL MEASURING INSTRUMENTS 61 0 Temperature measuring instru- ments 61 1 Pressure measuring instruments 61 2 Weight and volume measuring in- struments 61 3 Time measuring instruments 61 4 Velocity measuring instruments 61 5 Dimensional measuring instru- ments 61 6 Chemical composition measuring instruments 61 9 Miscellaneous mechanical measur- ing instruments	70 FUSES 70 0 125 volt fuses 70 1 250 volt fuses 70 2 600 volt fuses 70 3 4800 volt fuses 70 4 24 000 volt fuses 70 5 Fuse parts 70 6 Holders for fuses 4 800 volts and higher 70 9 Miscellaneous fuses
62 *	71 & 72 WIRE AND CABLE CONDUCTORS 71 0 Bare wire 71 1 Magnet and resistance wire 71 2 Weather proof wire 71 3 Rubber covered and other insu- lated wire 71 4 Telephone cable 71 5 600 volt cable 71 6 4 800 volt cable 71 7 7 500 volt cable (street lighting cable)
63 ELECTRICAL MEASURING INSTRUMENTS (EXCEPT ELECTRICITY METERS) 63 0 Ammeters 63 1 Voltmeters 63 2 Watthmeters 63 3 Reactive volt ampere meters 63 4 Frequency meters 63 5 Power factor, reactive factor and phase angle meters 63 9 Miscellaneous electrical measuring instruments	

\* Reserved for possible expansion of classification as need may arise in the future



Classification of Materials and Supplies (*Cont d*)

71 8 13 200 volt cable	82 3 Bells buzzers horns whistles annunciators sennaphores etc
72 0 24 000 volt cable	82 9 Miscellaneous communication and signaling equipment and supplies
72 1 Conductor connectors and termi- nals (bush)	83 BATTERIES AND BATTERY EQUIPMENT AND SUPPLIES
72 9 Miscellaneous conductors	83 0 Storage batteries
73 UNDERGROUND CONDUIT AND FITTINGS	83 1 Dry batteries
73 0 Fiber conduit and fittings	83 2 Battery chargers equipment and supplies
73 1 Clay conduit and fittings	84 APPLIANCES
73 0 Miscellaneous underground con- duit and fittings	84 0 Electric appliances (including ac cessories)
74 WIRING SUPPLIES	84 1 Parts for electric appliances
74 0 Metallic conduit and fittings	84 2 Gas appliances (including valves sies)
74 1 Steel boxes cabinets and panels	84 3 Parts for gas appliances
74 2 Receptacles plugs and sockets	85 SPECIAL GAS PLANT EQUIPMENT MAT- TERIAL AND SUPPLIES
74 3 Lighting fixtures and accessories	85 0 (Alphabetical arrangement)
74 5 Cutout bases (fuse blocks)	86 SPECIAL RAILROAD EQUIPMENT MATERIAL AND SUPPLIES
74 6 Special switchboard equipment and supplies	86 0 Locomotives
74 0 Miscellaneous wiring supplies	86 1 Railroad cars
75 *	86 2 Truck material
76 ELECTRIC INSULATION AND INSULATORS	87 MOTOR VEHICLES AND EQUIPMENT
76 0 Insulation	87 0 Passenger automobiles
76 1 Insulators	87 1 Trucks trailers and diggers
76 2 Insulator hardware	87 2 Tractors
77 LIGHTNING ARRESTERS	87 3 Motor vehicle accessories
77 0 (Arranged by voltage)	87 9 Miscellaneous motor vehicles and equipment
78 POTHEDS	88 FUEL (EXCEPT OIL)
78 0 Disconnecting potheads	88 0 Coal
78 1 Nondisconnecting potheads	88 1 Coke
79 STREET LIGHTING EQUIPMENT	88 0 Miscellaneous fuel
79 0 Overhead street lighting equip- ment	89 & 00 PETROLEUM AND COAL DISTILLATION PRODUCTS
79 1 Underground street lighting equipment	89 0 Fuel oil
79 0 Miscellaneous street lighting material	89 1 Gas enriching oil
80 LAMPS	89 2 Lubricating oil
80 0 Miniature lamps (16 volt and under)	89 3 Gasoline
80 1 18 to 32 volt lamps	89 4 Insulating oils and compounds
80 2 120 volt lamps	89 5 Greases
80 3 Series lamps (street lighting)	89 6 Paraffin and waxes
80 0 Miscellaneous lamps	89 7 Tar asphalt etc
81 *	89 0 Miscellaneous petroleum and coal distillation products
82 COMMUNICATION AND SIGNALING EQUIP- MENT AND SUPPLIES	90 *
82 0 Telephone equipment and supplies	92 CHEMICALS DRUGS AND COMPOUNDS
82 1 Radio equipment and supplies	92 0 Chemicals
82 2 Signs painted and electric	92 1 Medicinal compounds and for mules
	92 2 Cleaners and polishes
	92 3 Disinfectants and exterminators
	92 0 Miscellaneous compounds

\* Reserved for possible expansion of classification as need may arise in the future

Classification of Materials and Supplies (Cont'd)

<p>93 TEXTILES</p> <p>93 0 Fabricated textiles</p> <p>93 1 Unfabricated textiles</p> <p>94 MEDICAL EQUIPMENT AND SUPPLIES</p> <p>94 0 Medical equipment</p> <p>94 1 Gups and bandages</p> <p>94 9 Miscellaneous medical supplies</p> <p>95 JANITORS' EQUIPMENT AND SUPPLIES</p> <p>95 9 (Alphabetical arrangement)</p> <p>96 OFFICE EQUIPMENT AND STATIONERY SUPPLIES</p> <p>96 0 Furniture lockers and shelving</p> <p>96 1 Machines and accessories</p> <p>96 2 Paper</p> <p>96 3 Printed forms</p> <p>96 4 Books magazines etc</p> <p>96 5 Other stationery supplies</p>	<p>97 RESTAURANT EQUIPMENT AND SUPPLIES</p> <p>97 0 Restaurant equipment</p> <p>97 1 Food</p> <p>97 2 Sundries</p> <p>98 &amp; 99 ITEMS NOT OTHERWISE CLASSIFIED</p> <p>98 0 Explosives and firearms</p> <p>98 1 Safety equipment</p> <p>98 2 Fire fighting equipment</p> <p>98 3 Household furniture and furnishings</p> <p>98 4 Nursery supplies</p> <p>98 5 Special laboratory equipment</p> <p>98 6 Special construction equipment and materials</p> <p>98 7 Plating</p> <p>98 9 Miscellaneous</p> <p>99 0 Rubber goods</p> <p>99 1 Leather goods</p> <p>99 9 Material returnable to vendor (reels drums logging etc.)</p>
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**BIN TAG**—In many manufacturing concerns the storekeeper is required to keep a record (by quantities only) of materials and supplies kept in storeroom. This record is referred to as a bin-tag or perpetual inventory tag, and is usually in the form of a tag attached to a shelf, bin rack, etc., and carries the symbol and description of the material, location in storeroom and quantity in storage. In some plants a separate tag is written for each incoming lot of material, and the quantity, order number, and date of receipt of goods, are entered in appropriate spaces. When the material represented by the bin tag is issued in accordance with stores issue orders, the date and quantity issued is entered and subtracted from the previous total quantity shown on the tag. The final entry at any time upon the bin tag shows the quantity of material of the lot represented by it, remaining in the bin. As new lots of material are received in the storeroom, the bin tags are placed in pockets or on hooks in the bin, behind the tag in current use. No entries are made on the later tags until all the material represented by the one in use has been closed out, and the quantity represented by it reduced to zero. The amount of material shown on the bin tags upon which no issue entries have as yet been made, is noted on the closed-out bin tag. The closed out tag is then sent to the clerk in charge of the stores ledgers for checking with the quantity shown on the ledgers. The totals of these quantities should correspond with the quantity noted on the ledgers as on hand in the storeroom.

Fig 11 illustrates a different type of bin tag. In this type only one tag is used for each material, the receipts and withdrawals being recorded chronologically on the tag and the successive balances extended.

There are some objections to bin tags. Such a record is largely a duplication of the perpetual inventory record and offers too great an opportunity for inaccuracy in most cases. It puts a clerical function upon the storeroom men who ordinarily are not of the clerical type of



- 1 At a fixed time, such as the end of a year. It may be advisable to adopt a fiscal or natural business year, at whose end production is lowest and a minimum of raw materials and supplies is on hand.
- 2 At the time the purchase requisition is made out, since stock at that time is at or near the minimum.
- 3 Continuous count may be used, taking different sections of the stores room in rotation.
- 4 Periodic counts (weekly, monthly, or whenever convenient) of certain items in the stores room depending on the turnover and value of the item. Where materials are handled in large quantities and have high value such as copper cable, rubber, etc., a physical check up must be had more often than for materials which move slowly and have relatively small value.

Even though perpetual inventory records are kept, it is essential that a physical inventory be taken to correct discrepancies between the book records and the actual count that may have occurred because of errors, shrinkage, theft, and so on. The circumstances under which it may be necessary to take a physical inventory of raw materials and supplies are summarized in a bulletin of the National Association of Cost Accountants on the basis of information obtained through a questionnaire sent to its members (N. A. C. A. Bulletin, vol. 18).

1 Where the auditors require or the management desires that physical inventories be taken. In general public accountants and corporation officials are more reluctant to discontinue physical inventories than are industrial accountants who are more familiar with the operations of their perpetual inventory systems and more likely to appreciate the lack of necessity for a physical inventory.

2 Where the unit of measuring raw materials at the time of receipt differs from the unit of measurement at the time of issuance. In some industries, certain types of raw materials are purchased by the ton and issued by the foot or by the unit. Since a ton of a certain raw material will not always contain the same number of units, a physical count at the end of the accounting period is desirable.

3 Where the raw material is subject to shrinkage or loss while in storage. In such cases it would seem desirable that such raw materials be physically inventoried at the balance sheet date in order that all shrinkages to that date may be accounted for.

4 Where the raw material is of a type which makes it expensive to make accurate periodic checks. Thus a flour mill, a manufacturer of stock feed, or a brewery will have difficulty in measuring accurately the quantity of grains in elevators throughout the accounting period because of the varying moisture content, settling, and other factors. In such case estimates may be made throughout the accounting period and more accurate measure ment applied only at the close of the period.

5 Where the perpetual inventory records are not checked throughout the accounting period by physical count and measurement. In these companies stock records are checked only at the time physical inventories are taken. In other words, quarterly, semi-annual or annual inventories take the place of continuous check throughout the accounting period.

6 Where the perpetual inventory system is not accurate. If checks of the stock records indicate frequent and appreciable differences between the inventory figures and the quantities actually on hand due to errors in keeping the records, reporting receipts and issuances of raw material and in the measurement of raw material issued, a physical inventory at the end of the accounting period would seem to be necessary to discover all discrepancies.

**WHEN PHYSICAL INVENTORY NOT NECESSARY**—In contrast to the above the same source also sets forth those circumstances under which a physical inventory is not necessary. These circumstances are:

1 Where a portion of the raw material usually made up of slow moving items is not controlled by the stock records or where stock records are kept for such slow moving items but are not checked regularly throughout the accounting period. In such a case it would not appear necessary to take a complete physical inventory but only to take stock at the end of the period of the items not controlled or not checked regularly. The perpetual inventory records can then be used for that portion of the inventory which is adequately controlled and periodically checked to the book records. Of course, this can only be done if it is possible to eliminate accurately the portion of the inventory which is under control and be certain of including all raw material items in the physical count which are not so controlled.

2 Where the reason for taking a physical inventory is that the human element makes accurate stock records impossible. It is obvious that the human element is as important in the taking of a physical inventory as in keeping stock records and periodically checking them. In fact, the necessity for taking a physical inventory in a short period of time requiring the use of inexperienced help is likely to make errors due to the human element more frequent than in the keeping of perpetual records.

**PREPARATION**—Before the actual counting, weighing or measuring of raw materials and supplies begins, it is essential that the procedure to be followed be carefully planned and mapped out in advance. Inventory crews should be notified and given written copies of the plan in ample time to become familiar with it. These written instructions should cover the following points:

- 1 Date and time allotted for inventory taking
- 2 Organization of personnel and their individual duties
- 3 Instructions to various service and producing departments
- 4 Proper classification of items to be inventoried
- 5 Forms needed with explanation of their use

**Date and Time Allotted**—Inventory should be dated as of the end of the month so that it may be tied in with the financial records. Inventory should be taken within as short a time as possible so that there is a minimum of interference with operating activities. The ideal inventory period is the slack season that is the time when production is at its lowest and quantities on hand smallest. Use of such a period for a physical count enables management to employ its regular staff without disrupting to any great extent the movement of goods through the plant.

**Organization of Personnel and Their Individual Duties**—Of primary importance to management is the selection of someone to take charge of the inventory as a whole. The individual selected should be given complete authority and at the same time be held responsible for the entire inventory procedure. Various persons may be selected for this duty usually the controller, chief cost accountant, or purchasing agent. Sometimes the chief responsibility is vested in an inventory committee. After the chief of the inventory staff has been decided on,

the division managers or department heads are next in line of organization, then follow shop superintendents, foremen, and assistants who make out tags and list items thereon, and other workers who handle, count measure, or weigh inventory items. In large organizations a chart of personnel engaged in taking inventory is prepared and posted on plant bulletin boards.

Instruction sheets are next prepared outlining in general the inventory procedure to be followed. Copies of these instructions are put into the hands of all concerned in ample time so that each member of the inventory staff knows before the count is undertaken what is expected of him. Where possible detailed instructions are grouped about individual departments so that those concerned can concentrate on the work they are expected to do. Some plants hold group meetings for the inventory staff to be certain that all instructions are clearly understood before actual count begins. The following is quoted from Heckert (Accounting Systems) and illustrates that part of the general instructions relating to the responsibility for, and supervision of inventory taking in the case of a manufacturer of implements and machinery:

In Charge—World's auditor will be in general charge and all communications relative to inventory matters should be addressed to him.

World's manager will instruct foremen that they must personally supervise taking of inventory in their respective departments and that they will be held responsible for its thoroughness and accuracy.

**Supervision**—Foremen must see that all information as to kind of material, weight and quantities, location and other data called for on tags is correctly given. Foremen should inventory everything in their departments whether it belongs there or not. As soon as foremen have completed the inventory in their departments they must report to office so that they and their men may be used at some other point, and thus expedite the work.

**Instructions to Service and Producing Departments**—Each department in the plant should have everything in order before the count begins otherwise delays occur and many errors are made. To head off such delays and errors preparatory instructions are issued. The following quotation is taken from Heckert (Accounting Systems) and shows instructions given in written form covering the preparatory stage

$$D_1 \quad D_2 = 1 \quad 11 \quad 2 \quad = 1 \quad = 2 \quad = \dots 11 \dots = 1$$

1. *Journal of the American Medical Association*, 2000; 283: 2686-2692.

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1. *Journal of Management Studies*, 1996, 33, 1, 1-14.

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A summary of instructions to be issued is outlined by Bonthron (NACA Bulletin, vol 10)

1 Instructions to the stores departments to clean up to place all loose material in the proper bins etc., to segregate and transfer to the salvage department all obsolete supplies and scrap, and once the count in the stores has commenced to issue no stores without authority of some specified official

2 Instructions to the production departments to have all completely finished parts inspected and transferred to finished stores to clean up and transfer all defective and spoiled work and scrapped material to leave nothing under the benches or machines and to have nothing on the floor to be inventoried but actual work in process which should be grouped by job numbers or other suitable classification. At the same time, the advantage of having all assemblies completed will be pointed out and attention will be drawn to the fact that the stores department has received instructions not to issue any material once the count has commenced in the stores unless the requisition bears the O.K. of some specified official

3 Instructions to the inspection department to inspect finished products and work in process available and to bring up to date their schedules of defective items requiring only minor repairs to make them into satisfactory product

4 Instructions to the salvage department to inventory all the scrap or obsolete parts supplies etc in its possession

5 In addition instructions are issued to the receiving room to hold all goods received after the commencement of inventory taking until the conclusion thereof. Goods so received prior to the close of business on the inventory date should properly be included in the inventory of material on hand and the corresponding liability taken up in the accounts. The date of receipt should be indicated on the inventory tag which should be affixed to the goods as they enter the receiving room and the receiving slip should be stamped "Inventoried" before being passed on to the purchasing agent or accounting department

6 The purchasing department is required to list all invoices received for which the goods are not on hand at the close of business on the inventory date. It is considered proper to give effect in the accounts as of the closing date to the purchase of all goods bought on the f.o.b. vendor's plant basis which were actually in transit on the last day of the period

7 Similarly the shipping department is instructed to insure that all goods billed to customers but not shipped at the date of stocktaking are not included in the inventory

8 Instructions are also issued to the departments concerned to exclude from the inventory any goods which are not the property of the company including goods held on consignment for others and special tools loaned to the company

### CLASSIFICATION OF ITEMS TO BE INVENTORIED—

The various groups of items to be inventoried are indicated by account numbers as set forth in the general accounting classification. Articles to be inventoried are listed separately in instructions by classes such as

- 1 Raw materials
- 2 Factory supplies
- 3 Work in process
- 4 Finished parts
- 5 Finished goods
- 6 Perishable tools
- 7 Miscellaneous items
  - a Material received during inventory
  - b Materials received—no invoices
  - c Materials invoiced by vendors—not yet received
  - d Finished goods shipped—no invoices

- e Finished goods invoiced to customers—not yet shipped
- f Containers of vendors on hand charged to us
- g Goods out on consignment
- h Materials set aside for construction not yet charged to the accounts

**METHOD OF TAKING INVENTORY**—Instructions must be given in great detail covering the actual inventory taking, since much of the work is done by persons unfamiliar with it. The persons involved in the actual inventorying are the tag writers and the counters. The former can make the entire task easier by writing tags neatly and in legible figures. The quotation below is taken from Heckert (*Accounting Systems*)

Inventory must be taken by actual count weight and measurement or weight and count as the case may be. In instances where weighing or counting is not practicable estimates may be made (only in the presence of the works auditor, or a competent representative appointed by him).

The works auditor should select tag writers who are familiar with factory materials symbols etc. and information to be shown on inventory tags must be furnished by the foreman or his representative. Tag writers must be put to work as far in advance of the actual counting of inventory as possible so that when counting begins counters will not be held up waiting for tags to be written.

Tag writers are to fill in all information except count (and keep far ahead of material counters). If this is thoroughly done, counters will find tags attached to each individual lot of material and need only write the result of their count on tags. The tag writer will indicate on the tag how inventory is to be taken i.e. by count weight and count etc., so that material counter may know definitely the unit of measure to be used. [Then follow detailed instructions concerning the manner of listing different materials.]

**Counting**—When tag writers have progressed sufficiently so that they can keep ahead, men should be started on the work of counting material. The count should be entered on the tag in the proper space and a cross made in the upper left hand corner of tag. This indicates at a glance that material has been counted and count entered on tag. Each tag must be initiated by the person doing counting.

**Moving Stock During Inventory**—Stock may be transferred between two departments prior to the taking of the inventory in either department or after the inventory is entirely complete and tags pulled but under no circumstances shall stock move between departments during inventory. No stock shall be moved in a department while the inventory is in progress.

**Stock Located Outside of Buildings**—Stock located outside of buildings shall be given careful consideration in order that no omission may occur through misunderstandings as to departmental custody. Foremen shall confer with the works auditor and agree as to the custody and responsibility for inventory of all stock wherever located.

Where the line between departments is not definitely drawn, the foremen of the two adjoining departments must get together and make sure that all stock is inventoried, no matter in which department it may properly belong.

**FORMS USED IN TAKING PHYSICAL INVENTORY**—The principal forms used in taking physical inventory are inventory tags (Fig. 12) and inventory sheets (Fig. 13).



INVENTORY		JANUARY 31 19--	
N <sup>o</sup> 14824			
THIS SLIP MUST REMAIN WITH THE MATERIAL			
INVENTORY		JANUARY 31 19--	
N <sup>o</sup> 14824			
DETACH ONLY ON INSTRUCTION OF INVENTORY SUPERVISOR			
MATERIAL AND SUPPLIES			
KIND OF MATERIAL			
NET INVENTORY QUANTITY		UNIT	
COST PRICE		MARKET PRICE	
BIN NO	LOCATION	DEPT	
TAKEN BY		CHECKED BY	
CONDITION		REMARKS	
A			
B			
C			
H V			
NAME OF COMPANY			
JOHN VAN RANGE CO			
ADDRESS WHERE THIS IS STORED			
DO NOT DESTROY ANY TAGS			

ORIGINAL COUNT		UNIT	
DEDUCTIONS	DEDUCTIONS	ADDITIONS	
TOTAL ADDITIONS			QUANTITY
TOTAL DEDUCTIONS			
NET			
DATE OF LAST PURCHASE			
FROM WHOM			
UNIT PRICE			
TOTAL INVOICE			
DATE OF LAST SALE			
TO WHOM SOLD			
QUANTITY			
UNIT PRICE			
TOTAL INVOICE			

FIG 12 Inventory Tag (face and reverse)

Inventory tags are serially numbered and are charged to the various inventory captains. A record is made of the numbers of tags issued to different captains who are held strictly accountable for them. All tags must be returned and checked against the original list whether used, unused, voided, or spoiled. Inventory captains allot blocks of tags to assistants who fill them out, using indelible pencils, except as to quantity and attach them to the items to be inventoried. The checkers follow making physical count and signing the tag. When the inventory captain is satisfied with the work of tagging and checking, the lower part of each tag is pulled leaving the upper part attached to the items. After all tags have been accounted for they are compared with the perpetual inventory records. In the event of discrepancies, a recount is required.

The quotation below represents portions of the instructions issued by a machinery manufacturer, and is taken from Heckort (Accounting Systems).

Each tag will have a serial number, and be made out in duplicate. When tags are filled out, the original must be retained by the tag writer and properly put up in bundles in numerical order. The first and last tags

tags such tags should be marked. Shipped, order number noted, and tags turned in to the office.

After crediting a department with the original tags returned the tags will immediately be turned over to cost department for pricing. If tags are sorted into class order to facilitate pricing they should be re-sorted into numerical order after pricing and held until receipt of duplicates.

Tags should be pulled in the order in which they were attached so as to preserve the numerical arrangement. As fast as duplicate tags are pulled they are brought into the office and immediately matched up by numbers with the originals, to see that no numbers have been lost or destroyed.

**Inventory Sheets**—Tags are brought to the office and arranged numerically to see that all are accounted for. They are then re-sorted according to material classifications and entered on inventory sheets (Fig. 13). These sheets are also numbered consecutively and contain ordinary spaces for tag number, account number, description, quantity, unit prices, extensions, and footings. Extensions and footings are



STOCK RECORD														
Maximum 5,012			B n. B 12 14			Arl. cks. BUILT - FIL. NO. 1 64751			Account No. 12					
Minimum 2,000			RAW STOCK STORES			S r e			Unit S.F.M					
DATE	Issued From	Q. Mkt	V. Mkt	Per. Mkt	Per. Mkt	Ass. #	Received B	Def	Received From	Q. Mkt	V. Mkt	Per. Mkt	Per. Mkt	Received B
Oct 2, 1914	B. B. B. Co.	2,746	6,020	2,192	2,192	AB	AB	AB	AB	4,250	8,550	18	18	18,550
Nov 11, 1914	B. B. B. Co.	2,980	6,100	2,051	2,051	AB	AB	AB	AB					
Dec 11, 1914	B. B. B. Co.	2,020	4,140	2,051	2,079	AB	AB	AB	AB					
Jan 3, 1915	B. B. B. Co.	1,500	3,300	2,2	2,254	AB	AB	AB	AB					
Feb 1, 1915	B. B. B. Co.	1,500	5,075	2,051	2,094	AB	AB	AB	AB					
BALANCE														
RECEIVED					DELIVERED					BALANCE				
Q. Mkt	V. Mkt	Per. Mkt	Per. Mkt	Per. Mkt	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
2746	6020	7637	7637	7637	327	7169	327	7169	327	7169	327	7169	327	7169
2419	5203	4264	4264	4264	400	8770	400	8770	400	8770	400	8770	400	8770
1567	3234	2725	2725	2725	452	9910	452	9910	452	9910	452	9910	452	9910
1248	2725	2725	2725	2725	319	6994	319	6994	319	6994	319	6994	319	6994
4228	8843	8843	8843	8843	225	4707	225	4707	225	4707	225	4707	225	4707
4003	8374	8374	8374	8374	481	9995	481	9995	481	9995	481	9995	481	9995
5342	11515	11515	11515	11515	557	11573	557	11573	557	11573	557	11573	557	11573
4585	10222	10222	10222	10222	400	8312	400	8312	400	8312	400	8312	400	8312
					4	23	4	23	4	23	4	23	4	23

Fig 14 Adjusting Shortage on Stock Record

made by machine operators. The form illustrated is specially designed to make use of the lower of cost or market values.

**INVENTORY OVER AND SHORT REPORT**—The quantity balances of the various bin tags and inventory tags should agree with the quantity balances as kept by the stores ledger clerk.

Upon completion of the physical count the actual balance is compared with the balance on the stock ledger card. An overage exists when the physical balance exceeds the book balance. A shortage exists when the book balance exceeds the physical balance. The adjustments made must be carried to

- 1 Stores ledger card
- 2 Controlling account

In case of an **overage**, the stores ledger clerk adjusts the quantity on the ledger card either by a red ink entry in the Issued column or a black ink entry in the Received column. The effect in either case is to increase the quantity on hand; this increase is reflected in an increased balance in the On Hand column of the ledger card.

In case of a **shortage**, the stores ledger clerk records the discrepancy in the Issued column and adjusts the balance on hand. This is illustrated in Fig. 14 taken from Thompson (Accounting Systems), a physical count showed 4981 units on hand compared to 4,985 on the ledger card. The shortage of 4 units priced at the then current average unit price of \$20779 is recorded on the card as an inventory adjustment and the adjusted balance is brought down as the initial figure for the new year.

All differences are then summarized through an inventory over and short report, also called an inventory difference report (Fig. 15). This

INVENTORY DIFFERENCE REPORT						
DIVISION _____				DATE _____		
NO OF CARDS CHECKED _____				NO CORRECT _____		NO INCORRECT _____
NO	ITEM	COUNT	STORES RECORD QUANTITY	DIFFERENCE IN VALUE		
				UNIT VALUE	OVER	SHORT

FIG. 15 Inventory Difference Report

is done periodically. The report, taken from Heckett (Accounting Systems), forms the basis for a periodic journal voucher bringing the Stores controlling account into agreement with the adjusted stock ledger. If the totals on the report show a net overage, the following journal entry results:

Stores	\$	
Stores Adjustment		\$
or Inventory Over and Short		

If a net shortage is shown the controlling entry is

Stores Adjustment	\$	
or Inventory Over and Short		
Stores		\$

Stores Adjustment may be closed to Profit and Loss, or it may be treated as a standing order, in which case it is posted to the manufacturing expense ledger, with a similar posting to Manufacturing Expense control.

## Punched Card System of Inventory Control

**PRINCIPLES OF PUNCHED CARD ACCOUNTING**—The newest mechanical achievement in accounting is the use of sorting and tabulating equipment employing the punched card as a basic record. Two systems are in use:

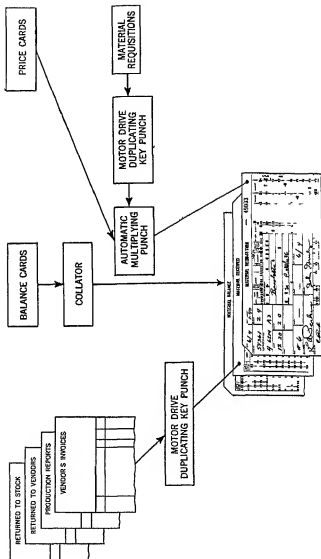
1. The Hollerith type, which is the basis of equipment built by International Business Machines Corporation.
2. Powers type, made by Remington Rand Inc.

The chief distinction between the two types is that, under the first type, the operator of the sorting or tabulating machine operates a plug board setting the necessary electrical contacts. In the Powers type, the plug board operates on a mechanical principle, is made at factory and thus a different plug board must be used for each task the machine is to perform. Subject to this basic difference, both types are able to perform approximately the same type of work. The illustration worked out below is based on the Hollerith system.

**USE OF PUNCHED CARDS IN ACCOUNTING FOR MATERIALS AND SUPPLIES**—Fig. 16 illustrates the electric machines and accounting forms used and also shows the flow of accounting data under the electric punched card accounting method. Three basic card forms are designed and used for recording transactions affecting materials and supplies. They are:

1. Material balance card.
2. Material received card.
3. Material requisition card (Fig. 16).

The balance card has fields laid out for date, type of transaction, material number, maximum and minimum quantities, quantity balance and amount balance. A separate card is punched for each item of material in stores that is, for each kind of raw material, semi-finished parts



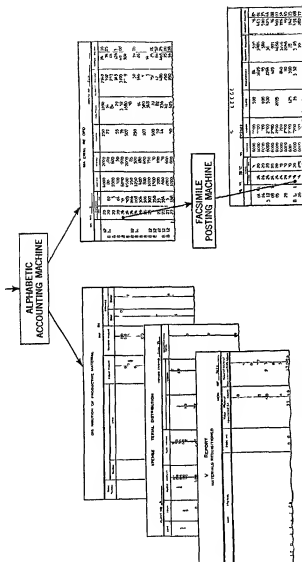


Fig 16 Flow Chart Illustrating Use of Punched Cards in Accounting for Materials and Supplies



and supplies. These cards are filed in the "balance card file" (Fig 16) by material number.

The received card has fields for date, type of transaction, material number, purchase or production order number, voucher number, quantity received, freight in, and amount of charge. Other data may be provided for if desired. These cards are punched from production orders, receiving slips, and vendors' invoices. The quantities and amounts punched on these cards are checked for accuracy against predetermined adding machine totals.

new one. Extensions may be performed by this method at the rate of 1,000 to 1,500 requisitions per hour.

Next the receipt, requisition, and balance cards are merged by the collator. In this operation, the collator rejects any balance cards which are not affected by the day's transactions. These cards are returned to the balance file. The merged cards are then tabulated by the electrical alphabetic accounting machine, creating a current material record (see Fig 16) of active items. This machine accumulates debits, credits, and balances and lists material number and maximum and minimum quantities. This operation is automatic, including the feeding of forms.

**Material Record**—Electrically attached to the accounting machine is an automatic summary punch. As the material record is being tabulated, this machine punches a new balance card for each item. These new balance cards are returned to the file in place of the ones removed. Thus the balance card file contains at all times the current balance on all stock items.

The material record forms are made up with transfer posting carbon paper. The carbon paper faces the back of the material record sheet so that as a material record is tabulated, a carbon copy appears on its back. Prepared in this manner, the material record sheet becomes a master copy to be used in conjunction with the facsimile posting machine.

**Stock Ledger**—An operator using the facsimile posting machine transfers the information from the material record to the stock ledger cards (Fig 16), a complete line at a time. Speeds of 500 to 1,000 postings per hour are obtained depending upon the number of active items as well as their proximity in the file. These speeds are attainable for two reasons:

- 1 Posting is in material number sequence and it is not necessary for the operator to search over a wide area of the file for the proper ledger sheet
- 2 It requires approximately one second to post a complete line

Note that balancing of stock ledger sheets under this method is eliminated. The postings are an exact duplicate of the daily material record. The stock ledger sheets are used only as an historical record of material activity. All analyses of stock transactions are made automatically from the balance, receipt, and requisition cards.

**Additional Uses of Material Cards**—After preparation of the daily material record, the current stock transaction cards are available for other uses, some of which are as follows:

- 1 Receipt cards may be an integral part of the accounts payable distribution if it is so desired. They can be sorted by accounts charged and automatically tabulated. Materials purchased may also be analyzed by vendors, by price, by class of material, etc.

- 2 Requisition cards can be used for various cost and expense analyses. For example, they may be tabulated in conjunction with labor distribution cards, automatically producing cost statements complete with labor burden, and material all charged to operations.

- 3 The expense distribution report shown in Fig. 16 illustrates a method for using requisition cards. A similar report may be prepared for each account, subdivided by departments. Requisition cards may be tabulated by expense accounts with budget cards showing actual and budgeted expense as well as variations over and under the budgeted amounts.

- 4 The value report shown in Fig. 16 illustrates another function of the cards. Here a tabulation of current requisition cards has been made in combination with summary cards of the previous month's usage. A summary card to be used with next month's report is automatically punched as the value report is prepared. The same principle can be followed in accumulating year-to-date figures or in making comparisons with same month of the previous year.

**USE OF PUNCHED CARDS IN TAKING PHYSICAL INVENTORY**—The use of punched cards in taking physical inventory is described in the booklet "Electric Punched Card Accounting Method" as follows:

A dual card (Fig. 17) is used to record the inventory count: one card for each item of stock. The cards are serially numbered both on the card itself and on the detachable stub. The serial number is prepunched at the card factory. The card provides for information in both written and punched form covering a description of the item in all details: its quantity, unit price, and total price.

The identifying information and unit price are written and punched previous to the inventory taking in order to reduce the time required later for listing the inventory and punching the cards.

The cards are issued to the inventory takers by serial number and each one must be accounted for when the cards have been returned to the accounting department and the listing of the serial numbers is completed.

The quantity of each item in stock is counted and written on the proper card, each count usually being checked by a second count. The cards are finally detached from their stubs and the stub is affixed to the article or



but as a visual indication that the item has been inventoried. The serial number on the stub serves to identify the latter with its card in the event that a recount of an item is desired to rectify an apparent mistake.

The cards are sorted by serial number and machine listed to detect any missing ones. After all cards have been accounted for it remains only for the quantity to be punched. Extensions are computed and punched automatically from the quantity and unit price already punched in the cards.

The cards are tabulated to obtain the required accounting totals either by departments or in total (Fig 18). Following this a listing (Fig 19) is made by stock number, which serves as a support for the accounting totals and as a cross reference with the previous listing by tag number.

Any special inventory analyses which are desired may be provided for by including the proper punching when the cards are originally prepared and are obtained by electric sorting and tabulating after the accounting work has been completed.

INVENTORY DETAIL (EXTENDED CARDS)							
PL. NO. / /				DATE September 19__			
S	I			N	U		
16	04	22	12500	136	450	1125	50625
16	2139	22	12501	210	200	750	15000
16	648	22	12502	125	190	1050	19950
16	2104	22	12503	193	350	1050	36750
16	1862	22	12504	168	210	975	20475
16	16		12505	215	380	1150	43700
16	1644	22	12506	177	350	1050	36750
16	200	22	12507	201	60	975	19500
16	1924	22	12508	139	10	750	23250

Fig 18 Detailed Inventory Sheets

INVENTORY REPORT (EXTENDED CARDS)					
PLANT <u>Fillmore</u>					
PART NO	DESCRIPTION	UNIT	QUANTITY	AMOUNT	
40304	CABLE IGN WIRE BRAIDED LARGE	FT	110	33	00
40305	CABLE IGN WIRE BRAIDED SMALL	FT	173	34	60
40306	STANDARD IGNITION WIRE	FT	800	16	00
40317	WIRE MANIFOLD CLAMP TUBE ASSY	EA	60	48	00
40318	PARK PLUG GROUND AS EMBLY	EA	31	46	50
40330	MAG SHIELD ASSEMBLY RH INSIDE	SET	32	65	84
40330	MAG SHIELD ASSEMBLY LH INSIDE	SET	32	65	84
40430	MAG SHIELD ASSEMBLY RH OUTSIDE	SET	30	67	50
4043	MAG SHIELD ASSEMBLY LH OUTSIDE	SET	34	76	50
40520	BAKELITE DISTRIBUTOR CLASS A	EA	10	30	00
40521	BAKELITE DISTRIBUTOR CLASS B	EA	12	24	00

Fig 19 Final Inventory Report

## Material Cost and Inventory Valuation

**RELATION OF MATERIAL COST TO INVENTORY VALUE**—The general rule of inventory valuation is cost or market whichever is lower but this is not definite enough since there are many different kinds of cost. A published balance sheet may contain an asset "Inventory (at cost)" but this item might have different values opposite it every one of which would represent some kind of cost. The question therefore is not one of different methods of pricing to achieve same results. In this case different methods produce different results, that is different methods of pricing stores issues produce

- 1 Different material costs of jobs and products
- 2 Different inventory values

An incorrectly priced inventory may result in a false statement of profit or loss with injury to stockholders and others. It may produce an erroneous statement of the working capital position and thereby make a misleading impression upon the creditor. It may also result in a substantial modification of the income tax to be paid. Correct inventory valuation is therefore, at the heart, not only of good cost accounting but sound management as well.

**BASIS OF MATERIAL COSTING**—Whether materials should be transferred at cost or at cost plus a profit is an open question. Heckert states (N.A.C.A. Year Book, 1930)

The writer has made a survey of 41 companies including both large and small concerns and representing some 25 different lines of business. The result of this survey indicates the following practice

Concerns using cost throughout	29	70%
Concerns using market in certain instances	8	20%
Concerns using arbitrary values in certain instances	4	10%
	41	100%

This would seem to indicate that most concerns use cost and even in 12 companies which in certain instances use other methods the use of cost predominates.

In the 12 exceptions the reasons for using methods other than cost are as follows

To give the department or branch independence from a profit and loss standpoint	6
To keep certain of the personnel in ignorance of the cost	3
Trade association purposes	2
More expedient from a clerical standpoint	1
	12

**METHODS OF COSTING**—When materials and supplies are issued to the factory the quantities recorded on stock ledger cards must be translated into dollar values. Several methods of costing requisitions and pricing inventories are used, the most important of which are

- |                      |                                      |
|----------------------|--------------------------------------|
| 1 Specific cost      | 7 Standard cost                      |
| 2 First in first out | 8 Last in first out                  |
| 3 Simple average     | 9 Replacement cost                   |
| 4 Weighted average   | 10 Normal or base stock              |
| 5 Periodic average   | 11 Cost or market whichever is lower |
| 6 Moving average     |                                      |

Some of the above methods are used both for pricing stores issues and for valuing inventory on hand at the end of period. Other methods are used exclusively for inventory valuation.

Of the different cost methods, the first six can be considered as variations of actual cost. There is no one method that can be used under all conditions. One method may be suitable in one industry but not in others. The method to be used under any given set of conditions is one under which realized or realizable income is most closely approximated. In some cases this may mean the use of different methods in different departments of same plant.

Actual cost or historical cost of raw materials work in process and finished goods is the most logical method to use from the standpoint of cost accounting, since most accounting data are usually recorded on a cost basis. There are many variations of the actual cost method such as first in first-out, moving average, straight average, weighted average and last in first-out. Actual cost in the case of raw materials and supplies consists of the sum of net invoice price, transportation charges inward and purchasing handling and storage costs. As a matter of practice however purchasing, handling and storage costs are seldom included when inventory is priced, being treated as part of manufacturing overhead.

Actual cost in the case of work in process and finished goods means that charges for material, labor and manufacturing overhead are accumulated against the goods on hand. When subsidiary cost and inventory records are kept, the work in process inventory is ascertained from data accumulated on cost sheets of unfinished jobs, and the value of finished goods is determined from data found on individual stock records. The chief argument advanced for the use of actual cost in pricing inventories is that no unrealized profits or losses are brought on the books to affect current operations. The objection raised to the use of an actual cost method of valuation is that the true financial condition may not be revealed if market prices have declined or advanced in comparison with actual costs. This may be overcome, however, by the use of an inventory reserve, or by setting forth the market value parenthetically or as a footnote to the balance sheet.

**SPECIFIC COST METHOD**—Under this method, purchases made for particular jobs are kept separate in the storeroom and stores cards are made out for the individual purchases. When materials are issued for jobs requisitions are priced at the exact cost as recorded on the appropriate stores cards. This system may be somewhat awkward, but is employed effectively when nonstandardized units have to be purchased to meet a customer's specifications. Some concerns operating on a job order basis use this method to price issues of materials not regularly carried in stock and use some other methods to cost materials regularly used in production.

**ORIGINAL COST OR FIRST-IN FIRST-OUT METHOD**—The original cost or first-in first-out method assumes that items first received are the first to be issued and that requisitions are priced at the cost at which these items were placed in stock. For example if 100 units of material X are purchased at \$1.00 per unit, and later 200 units at \$90 per unit, first 100 units to be used are priced at \$1.00 per unit, and

DATE	RECEIPTS		ISSUES			INVENTORY
	QUANTITY	UNIT COST	QUANTITY	UNIT COST	AMOUNT	QUANTITY
JAN 5	100	\$1.00				100
7			30	\$1.00	\$30.00	70
10	200	.90				270
15			70 } 40 }	1.00 90	106.00	160
18	100	1.10				260
20			50	.90	45.00	210

FIG 20 First In First Out Method

next 200 units at \$ .90 per unit. In the use of this method care must be exercised in pricing requisitions filled from two or more lots (Fig 20)

**Conditions Favoring Use of Original Cost**—The first-in first-out method of pricing can be used to best advantage in industries where inventory items do not move very fast and have a high unit cost. In most cases this method is very simple to use and has the added advantage of showing the actual cost of goods used and on hand. It may be very cumbersome, however, if several purchases are made at different prices making it necessary to account accurately for several different priced lots. Criticisms of first-in first-out method have been made in recent years particularly in the tanning, oil, copper, brass, copper wire and lead industries on the ground that it fails to recognize the fact that sales are made against current purchases and not against inventory, with the result that true income is distorted by fluctuations in inventory values. Many of these industries have abandoned this method of pricing requisitions and have adopted the last-in first-out method (described later in this Section).

Under first-in first-out method inventory value is determined by consulting individual stores cards. Quantities and values of the most recent entries thereon are accumulated until they equal the quantity on hand. The computation is as shown below:

Total received (Fig 20)	400
Total issued (Fig 20)	<u>190</u>
Balance on hand	<u>210</u>

The value of the 210 units on hand at the end of the month can be determined from the cost of the most recent purchases and working backwards:

100 units from the purchase of January 20, valued at \$1.10 each	\$110.00
110 units from the purchase of January 10, valued at \$.90 each	<u>99.00</u>
Total	<u>\$209.00</u>

This method, sometimes called the "most recent purchase" plan, may be used to advantage in pricing inventories where no stores records are kept. Under this situation the most recent invoices are analyzed for unit prices which are applied to the quantities on hand as shown on the inventory sheets.

**Advantages of First In First-Out Method**—There are no serious theoretical or technical objections to this method except in the case of obsolete, shopworn, or slow-moving goods. There are certain advantages which may be summarized as follows:

- 1 It is based on cost, and hence raises no question of unrealized in come or loss.
- 2 It is drawn from the actual records in a systematic manner without the use of estimates.
- 3 It conforms to sound principles of economics and business in that the resulting inventory value is usually a fair representation of current commercial values.
- 4 It is based upon a clear cut assumption as to the movement of goods through the storesroom, which it is good business for the management to adhere to as closely as possible.
- 5 It is approved by the Bureau of Internal Revenue.
- 6 It is a convenient method to use in pricing under any continuous inventory system.

**Pricing Materials Returned from Factory to Storesroom**—One method of handling returned stores is to treat the return as a new purchase, entering it in the Received section at the issued price and carrying it forward as the last item in the Balance section. A second method is to enter it in red in the Issued section and extend it in the Balance section as above. A third method is to record the return at the original price in the Received section, carry it forward in Balance section as the first item, and charge it out on the next requisition at the old price.

**SIMPLE ARITHMETIC AVERAGE**—In practice, there are many forms of averaging in connection with the pricing of stores requisitions and inventory on hand. Some of the methods in use are as follows:

- 1 Simple arithmetic average
- 2 Weighted average
- 3 Moving average
- 4 Moving average at close of preceding month

The simple average is determined by dividing the total of all unit prices by the number of invoices, the quantity on each invoice being ignored. The schedule below taken from Kester (Advanced Accounting) is an illustration.

Date	Quantity Bought (units)	Unit Price	Cost
January 10	30	\$11 00	\$ 330 00
February 1	5	12 00	60 00
March 6	40	10 00	400 00
April 5	10	11 50	115 00
May 20	50	9 50	475 00
June 15	20	12 00	240 00
Totals	<u>155</u>	<u>\$66 00</u>	<u>\$1 620 00</u>



The straight average price per unit is \$11 found by dividing the total of all unit prices (\$66) by the number of invoices (6). If there are 40 units on hand on June 30, the value of the inventory would be  $40 \times \$11$  or \$440. The method has nothing to recommend it. It is an unweighted average and likely to produce absurd results. Thus in the above illustration, if 115 units are issued and 40 are on hand, their values are as follows:

$$\begin{array}{r} 115 \times \$11 = \$1,265 \\ 40 \times \$11 = \underline{440} \quad \underline{\$1,705} \end{array}$$

The total cost, however, was only \$1,620 as against an issue price of \$1,705.

**WEIGHTED AVERAGE METHOD**—This method is used by those concerns which desire to spread total costs evenly over all goods on hand. To calculate the weighted average unit cost, the procedure is:

- 1 Add total quantity received to total quantity on hand
- 2 Add cost of materials received to cost of those on hand
- 3 Divide total values by total quantities

Average unit cost is used in pricing requisitions and balances on hand until new purchases are received when it is necessary to calculate a new average unit cost. The arithmetic involved in this method is illustrated in Fig. 21. The value of the ending inventory is found as follows:

- |   |   |           |
|---|---|-----------|
| 1 | Units on hand                                 | 210       |
| 2 | Last average unit cost                        | \$ .99288 |
| 3 | Value of inventory ( $210 \times \$ .99288$ ) | \$208.50  |

DATE	RECEIPTS		ISSUES			INVENTORY
	QUANTITY	UNIT COST	QUANTITY	UNIT COST	AMOUNT	QUANTITY
JAN 5	100	\$1.00				100
7			30	\$1.00	\$30.00	70
10	200	.90				270
15			110	.92593	101.85	160
18	100	1.10				260
20			0	.99288	49.54	210

FIG. 21 Weighted Average Method

**Degree of Accuracy in Unit Costs**—This method is used to advantage when the price of the same material fluctuates frequently during a period. To avoid errors in pricing issues and inventory balances it is necessary to carry sufficient decimals in the average unit cost to insure accuracy to the nearest cent. The number of decimals to be carried therefore, depends entirely on the size of the multiplier. If the latter is small fewer decimals are required, as the multiplier increases more decimals are required. In Fig. 21 five decimals represent the minimum to insure the desired accuracy.

If this condition is not observed, adjustments may become necessary to bring the dollar balances of the stores cards into agreement with the Raw Materials control account. To avoid making adjustments of this nature, a new balance may be determined by subtracting the total value of requisitions priced at the average unit cost, or the total value of the requisitions may be found by deducting the new balance priced at the average unit cost. This procedure may be alternated from time to time so that total quantities requisitioned and on hand when multiplied by average unit cost will not get too far out of line with the values shown on the stores cards.

The weighted average method has the same disadvantage as first-in first-out method in that a considerable amount of detailed work is required in computing averages in pricing requisitions, and in keeping stores records up to date. Another disadvantage of the method lies in the fact that high or low prices paid in the past for material are reflected in the average long after the material purchased at such high or low prices is consumed. Thus, although it may require many calculations it has the advantage of stabilizing costs when prices fluctuate rapidly.

**Pricing Material Returned**—When excess materials are returned to storeroom, they should be treated as a new purchase, entered in the Received section at issued price added to quantities and values in the Balance section and a new average unit price computed. An alternative method that may be used when returns are of small value is to enter in the Received section and extend into the Balance section at the issued price, charging the amount to the next requisition received.

**PERIODIC AVERAGE METHOD**—This method of pricing requisitions is a variation of the weighted average method. Instead of computing an average unit cost after each purchase, the computation is delayed until the end of some period, usually a month. Issues of material are then priced at the average unit cost obtained by dividing the total value of the beginning inventory and purchases for the month by the total quantities available during the month. Expressed as a formula, this becomes

$$U = \frac{V_i + V_p}{Q_i + Q_p}$$

where  $U$  = Periodic average unit cost

$V_i$  = Value of inventory at beginning of period

$V_p$  = Value of purchases for period

$Q_i$  = Quantity of inventory at beginning of period

$Q_p$  = Quantity of purchases for period

In the example in Fig. 22, there is no opening balance, hence,

$$U = \frac{0 + \$300}{0 + \$400} = \$075$$

The application of the method is shown in Fig. 22. The value of the ending inventory is

$$210 \times \$075 = \$204.75$$

**Value of Periodic Average Method**—The chief advantage of using the periodic average method is that much detailed clerical work is eliminated. Under this method, the average costs need be computed only once a month also it is unnecessary to identify issues of materials with particular quantities received. This procedure in pricing requisitions is often followed by process industries where the cost of production is not determined until the end of the month. It is of little value, however in job order concerns, where costing is necessary during and upon completion of a job.

The disadvantage of the method lies in fact that the pricing of requisitions and costing to Work in Process must be held in abeyance until the end of the month. This, therefore, creates peak loads of work at a very inopportune time. At the end of the month, the stores ledger clerk is busy preparing inventory balances to be reconciled against Stores control; the cost department is busy getting out monthly statements. All this would be delayed under periodic average method. In order to overcome disadvantage involved in holding up the pricing of requisitions until the end of the month, some concerns use the average calculated at the end of each month to price requisitions for the following month. In this way all requisitions in a given month are priced at the average calculated for the preceding month and no delay is involved. Referring to Fig 22, stores issues for February are priced at

DATE	RECEIPTS		ISSUES			INVENTORY
	QUANTITY	UNIT COST	QUANTITY	UNIT COST	AMOUNT	QUANTITY
JAN 5	100	\$1 00				
7			30	\$ .975	\$ 29 25	
10	200	.90				
15			110	.975	107 25	
18	100	1 10				
20			50	.975	48 75	
31	400	\$390	190			210

FIG 22 Periodic Average Method

\$ .975, while January requisitions are priced at a figure calculated at the end of December. This last criticism applies, of course, to all methods involving a determination of prices at the end of a cost period, e.g., to the simple average method.

**MOVING AVERAGE METHOD**—This is a variation of the weighted average method. It is particularly suitable for use where raw material is subject to constant price fluctuations. Under such conditions, it is desirable to stabilize the charges to Work in Process. This is the case in oil refining, where crude oil is charged out to operations on the

basis of a six months' moving average. The figures below illustrate the method of computing the moving average.

Month	Price (in cents)	Moving Average
January	50	
February	52	
March	58	
April	56	
May	55	
June	55	543
July	53	548
August	56	555

The June average is arrived at by averaging the previous six months' prices. The July average is computed by dropping January and adding July, and then averaging, etc. Note that under such a scheme charges to Work in Process are somewhat stabilized, extreme fluctuations in monthly prices are dampened in the moving averages. Another advantage is that high or low prices paid sometime in the past are removed from the computation, and do not influence the average after six months.

**STANDARD COST METHOD**—Under this method requisitions of materials are priced at some predetermined or standard cost. The accounting procedure for materials under a standard cost system depends upon which of following methods are used:

1. Materials kept at actual costs on stores cards and priced into process at standard.
2. Materials kept at standard cost on stores cards and priced into process at standard.

If stores ledger accounts are to be kept on an actual cost basis, and requisitions priced at standard, the stores ledger clerk keeps his records in the usual manner, but the cost clerk uses the standard prices on the cost sheet, the difference between actual and standard cost being handled through a Material Variance account. (See Section 7 on Operation of Standard Costs.)

When standard costs are used from the point of receipt on through production, the accounting procedure for the receipt and issue of materials is greatly simplified. Under the latter method only quantities of receipts and issues need be recorded on stores cards. When materials and supplies are received, the Stores control account is charged at standard cost, the difference between actual and standard being charged or credited to a Material Price Variance account. At the same time the quantity received is entered on the proper stores card in the Received and Balance sections, the standard unit price being noted at the top of the ledger card. When requisitions are made, entries for quantities only are placed in the Issued sections, and deducted in the Balance sections of the appropriate stores card. The standard costs of materials to be used on each job may be recorded on a cost sheet in advance. It is necessary for the cost clerk to determine from time to time the variation in quantity used, the latter being handled through a Material Use Variance account.

The chief advantages of the standard cost method of pricing stores issues are

- 1 Simplicity
- 2 Obtaining material control through
  - a Material Price Variance account
  - b Material Use Variance account
 These accounts reveal the relative efficiencies in purchase and use of materials
- 3 Reduction in clerical costs through
  - a Elimination of cost column on stores ledger card
  - b Elimination of repeated unit cost calculations

**LAST-IN FIRST OUT METHOD**—This method of pricing requisitions, frequently called the replacement cost method, assumes that the last items purchased are the first to be used, the balance on hand being priced at the cost of the earliest purchases. By this method current income (sales) is charged at current (replacement) cost. For example, if 200 units of material X are purchased at 50 cents per unit and later 400 units at 60 cents per unit, the first 400 units to be used are priced at 60 cents per unit, and next 200 units at 50 cents per unit. As in the first-in first-out method, care must be exercised in pricing requisitions calling for two or more lots and in recording balances on stores cards when two or more different priced lots are on hand.

The arithmetic involved in keeping stores records under this method is similar to that necessary under the first-in first-out procedure. The point to remember is that requisitions are priced at the cost of the most recent purchases (Fig 23).

DATE	RECEIPTS		ISSUES			INVENTORY		
	QUANTITY	UNIT COST	QUANTITY	UNIT COST	AMOUNT	QUANTITY	UNIT VALUE	TOTAL
JAN 5	100	\$1.00				100	\$1.00	\$100
7			30	1.00	\$30.00	70	1.00	70
10	200	.90				70	1.00	
						200	.90	250
15			110	.90	99.00	70	1.00	
						90	.90	151
18	100	1.10				70	1.00	
						90	.90	
						100	1.10	261
20			50	1.10	55.00	70	1.00	
						90	.90	
						50	1.10	205

FIG 23 Last In First Out Method

The principal advantage claimed for this method is that the cost of goods manufactured and sold during a period is stated more nearly at current market prices, and unrealized inventory profits are not re-

lected in the accounts. On the other hand since inventories are valued at prices paid for the oldest goods adjustments involving large amounts may be necessary to bring values into agreement with the cost or market rule.

**Variations of Last-In First Out Method**—There are several variations of the last-in first out methods. Essentially, this method of pricing inventory assumes that goods used or otherwise disposed of are those most recently acquired, the balance on hand being made up from oldest stock. This is explained by Albion Davis (N A C A Bulletin, vol 19) as follows:

In closing your books at any time you simply back up on your purchases, starting with the most recent, and when a quantity equivalent to sales has been reached, that is your cost of sales. However it is not nearly so simple as that if the true result is to be obtained. You either have to take your opening inventory and use it forever after as a reservoir from which at the unit values existing when you started, you borrow and to which you pay back differences in quantity between current sales and purchases or you have to figure the first period, and then the first and second together as a single period and then the first second and third together and so on interminably with the differences between these successive totals giving the results for individual periods. Of course, what is actually done in most instances where this method is used is that these figures are taken for interim reports and then some figure adjusted by expediency is used at the end of the year and a fresh start taken for the next year.

**Cost of Sales Determination**—The purpose of the last-in first out method as expressed by Graham (N A C A Bulletin, vol 18) is,

that the revenue from high sales prices be burdened with the high costs which brought about the high sales prices and not leave high priced inventories to be absorbed in later periods by revenue at a lower price level. The last in first out method looks to the longer economic period and the eventual return of low prices after a high level interim.

The method was adopted by the American Petroleum Institute in 1934 revised in June, 1936. The Institute's method is a variation of last-in first out, and is explained by Graham as follows:

During periods of rising prices, inventories valued on the basis of "first in first out" will aggregate a larger valuation than on the basis of "last in, first out", conversely in a period of falling prices inventories valued on the basis of "first in, first out" will aggregate a lower valuation than upon the basis of "last in first out". The basis of cumulatively averaged cost takes the middle ground between these two bases. In other words their effect upon the income accounts is a closer correlation of current sales prices and current purchase costs.

**Inventory Valuation**—The peculiarities of the American Petroleum Institute's method of inventory valuation are explained by Graham as follows:

The "last in, first out" method as enunciated by the American Petroleum Institute does not require the inventory prices to be reduced to market prices where lower than the regular inventory value presumably on the assumption that the inventory value adopted at the outset of the "last in, first out" method will be so conservative that the price level thus shown in the inventory will be lower than that which ordinary market fluctuations may be expected to reach. It also presumes that those occasions

## CLOSING INVENTORIES

	Last In First Out Basis (A. P. I. Method)			Lower of Cost or Market Basis			Inventory Increase (+) or Decrease (-)	
	Units	Price	Amount	Units	Price	Amount	Normal	Lower of Cost (+) or Market (-)
First Year	950 000	\$1 00	\$ 950 000	950 000	\$1 10	\$1 045 000	\$ 50 000—	\$ 45 000+
Second Year	850 000	1 00	850 000	850 000	1 10	937 500	102 500—	67 500—
Third Year	750 000	1 00	750 000	750 000	1 25	1 012 500	100 000—	25 000+
Fourth Year	700 000	1 00	700 000	700 000	1 35*	945 000	50 000—	67 500—
Fifth Year	700 000	1 00	700 000	800 000	1 20*	960 000	0	0
	100 000	1 20	120 000	0	0	0		
Sixth Year	800 000	\$1 02½	\$ 820 000	800 000	\$1 20	\$ 960 000	120 000+	15 000+
	800 000	\$1 02½	\$ 820 000	1 100 000	\$1 00	\$1 100 000		
	300 000	1 00	300 000					
Seventh Year	1 100 000	\$1 0182	\$1 120 000	1 100 000	\$1 00	\$1 100 000	300 000+	140 000+
	1 100 000	\$1 0182	\$1 120 000	1 200 000	\$ 90	\$1 038 000		
	100 000	90	90 000					
Eighth Year	1 200 000	\$1 0083	\$1 210 000	1 200 000	\$ 90	\$1 080 000	90 000+	20 000—
	1 200 000	\$1 0083	\$1 210 000	1 250 000	\$ 80	\$1 000 000		
	50 000	80	40 000					
Ninth Year	1 250 000	\$1 00	\$1 250 000	1 250 000	\$ 80	\$1 000 000	40 000+	80 000—
Tenth Year	1 100 000	\$1 00	\$1 100 000	1 100 000	\$ 80	\$ 880 000	150 000—	120 000—
	1 000 000	1 00	1 000 000	1 000 000	1 00	1 000 000	100 000—	120 000+

\* Market.

Fig 24 Comparative Closing Inventory Values (ten year cycle)

## PROFIT AND LOSS STATEMENT

Last In First Out Basis (A. P. I. Method)	First Year	Second Year	Third Year	Fourth Year	Fifth Year	Sixth Year	Seventh Year	Eighth Year	Ninth Year	Tenth Year
Sales	\$1 875	\$2 125	\$2 400	\$2 275	\$1 485	\$1 250	\$1 815	\$2 050	\$2 042 5	\$2 070
Cost of Sales										
Opening Inventory	\$1 000	\$ 950	\$ 850	\$ 750	\$ 700	\$ 620	\$1 120	\$1 210	\$1 250	\$1 100
Purchases	1 950	1 800	2 025	2 000	1 440	1 450	1 575	1 680	1 600	1 700
Less—Closing Inventory	\$3 955	\$2 750	\$2 875	\$2 750	\$2 140	\$2 270	\$2 695	\$2 890	\$2 850	\$2 800
Total Cost of Sales	950	850	750	700	820	1 120	1 210	1 250	1 100	1 000
Profit	\$1 645	\$1 940	\$2 175	\$2 075	\$1 320	\$1 150	\$1 485	\$1 640	\$1 750	\$1 600
	\$ 250	\$ 185	\$ 275	\$ 225	\$ 165	\$ 250	\$ 350	\$ 410	\$ 292 5	\$ 270
Lower of Cost or Market Basis										
Sales	\$1 875	\$2 125	\$2 400	\$2 275	\$1 485	\$1 250	\$1 815	\$2 050	\$2 042 5	\$2 070
Cost of Sales										
Opening Inventory	\$1 000	\$1 045	\$ 975	\$1 012 5	\$ 945	\$ 920	\$1 100	\$1 080	\$1 000	\$ 880
Purchases	1 955	1 840	2 025	2 000	1 440	1 450	1 575	1 680	1 600	1 700
Less—Closing Inventory	\$2 955	\$2 885	\$3 002 5	\$3 012 5	\$2 855	\$2 410	\$2 675	\$2 760	\$2 690	\$2 530
Total Cost of Sales	1 045	975	1 012 5	945	960	1 100	1 080	1 000	880	1 000
Profit	\$1 850	\$1 907 5	\$1 900	\$2 067 5	\$1 425	\$1 310	\$1 595	\$1 750	\$1 720	\$1 580
	\$ 325	\$ 217 5	\$ 410	\$ 307 5	\$ 60	\$ 70	\$ 220	\$ 280	\$ 322 5	\$ 490

FIG 25 Comparative Profit and Loss Statements Based on Different Inventory Valuations



when market prices are below the inventory values are only temporary and unusual conditions from which a prompt recovery is looked for

**Importance of Last in First Out Method**—The American Institute of Accountants in collaboration with the American Petroleum Institute arrived at the following conclusions concerning valuation under the last-in first out method

The "last in first out" method for the valuation of oil company inventories as recommended by the American Petroleum Institute constitutes an acceptable accounting principle for those companies which finding it adaptable to their needs and views as correctly reflecting their income apply it consistently from year to year it is important, however that full and clear disclosure in their published financial statements be made by the companies adopting it both as to the fact of its adoption and the manner of its application including information as to the period adopted for the unit of time within which the goods last in are to be deemed first out that is whether the fiscal year or a shorter or longer period

Since the method as outlined by the Committee of the American Petroleum Institute requires that the valuation be placed upon the inventory be conservative or reasonable without however providing for a uniform standard or common basis in the determination of such valuations it must be understood by readers of the financial statements of companies adopting the method that the inventory valuation of one such company is not to be regarded as comparable with that of another except only in so far as the current replacement valuation arrived at under the method affords such a comparison

The foregoing conclusion of our Committee however does not preclude our viewing other methods as being either equally acceptable or preferable in the case of other companies where different conditions may prevail

Fig 24 shows the application of the method to an assumed ten year cycle of transactions and compares it with the cost or market basis Fig 25 shows the resulting profit and loss statements on the two bases Both are taken from Graham (N A C A Bulletin vol 18) Note that the last in first out methods produce on the whole the smaller year-to-year profit fluctuations although at the end of the ten year cycle the same total of profits (\$2 612,500) has been accounted for

**Application of Last In First-Out Basis to Monthly Statements**—The uniform method of valuing petroleum inventories on a year-to-date basis provides for obtaining cumulative cost of sales figures Fig 26 shows the application of the method over a full year The opening inventory for the year is taken as a base for inventory valuation according to the Petroleum Institute's rules, as follows

So long as the quantity on hand is not in excess of the opening inventory for the year the closing inventory price will be the same as the opening inventory price

At the end of any month if the quantity on hand exceeds the opening inventory for the year such excess will be priced at the average to date production or purchase cost

The January figures are obvious For February, proceed as follows

- 1 Insert on line 4 the February figures for production (quantity, unit cost, total cost) also the quantity sold
- 2 Obtain cumulative January-February totals The illustration shows 400 units costing \$34 or an average unit cost of \$85



- 3 Value cumulative quantity sold (325 units) at the cumulative average unit cost (\$ 085) obtaining the cumulative cost of sales (\$27 63)
- 4 Subtract January cost of sales from the cumulative total the balance being cost of sales to be charged to February (\$14 13)
- 5 Divide February cost of sales by quantity sold to obtain February unit cost of sales (\$ 08074)

The same procedure is followed each month, in March only 575 units were produced at a cumulative average cost of \$ 08043, however, 600 were sold, these are therefore valued as follows

575 at \$ 08043  
25 at \$ 10

Last 25 units are considered to have been borrowed from opening inventory for the year. The latter is the base stock for the year. When inventory once more rises to the level of the opening balance, the quantity borrowed is considered as being restocked at the opening value. Thus in April 125 units are on hand at the end of the month. These are valued as follows

100 at \$ 10 (base figure for the year)  
25 at \$ 07891 (cumulative average cost)

**Appraisal of Last In First-Out Basis**—Proponents of this plan claim a greater stability of earnings from year to year and that the resulting accounting records provide a better guide to management. It is favored particularly by industries where profits are inherently unstable such as petroleum tanning, and mining. It is now recognized by the Bureau of Internal Revenue for income tax purposes.

One objection to this method is that inventory values are determined by the oldest lots on hand, prices of which may be entirely out of line with those of current invoices. Obviously, if there has been no change in quantities on hand at subsequent inventory dates, the value of the balance on hand would remain the same, being priced at the amount paid for the original lots. If the cost of original lots does not agree substantially with cost of recent purchases, inventory values will be misstated and a false picture of working capital position will be presented.

**REPLACEMENT COST METHOD**—It has been stated frequently that the replacement cost method and last-in first out method of pricing requisitions are virtually the same. This is true only when the latest price of purchases as recorded on the books is identical with the current replacement price at the time of issue. It is possible that in many cases there is a difference in these prices. As to valuation of inventory seldom if ever, would these prices be the same under the two methods. Under the last-in first-out method of valuation the inventory is priced at the cost of oldest stock, whereas under the replacement method the inventory is valued at the amount it would cost to replace it at current prices in its present condition.

Practical difficulties arise in applying this method particularly in connection with valuation of inventories in some manufacturing concerns. In the case of raw materials and supplies, the current invoice price must be determined for hundreds of items on the inventory date, taking into consideration the quantities usually purchased. Often current quotations

are not available and as a result pricing becomes largely a matter of opinion. In the case of work in process and finished goods inventory, valuation on the replacement basis becomes exceedingly difficult. It is necessary to ascertain current prices not only for raw materials but also for labor and manufacturing overhead. This may be practically impossible especially with some manufacturing overhead items.

The replacement cost method is sometimes recommended in industries where the finished product is composed largely of raw material the current market price of which is closely related to the selling price of finished article. Concerns making a finished product the cost of which is made up largely of cotton, wheat or copper are examples of such industries. The objections to this plan of valuation are summarized below:

- 1 It is not approved for income tax purposes by the Bureau of Internal Revenue.
- 2 It is viewed as nonconservative by accountants, bankers, and business men generally.
- 3 It requires the determination of replacement costs for the entire stock at inventory date, a considerable task especially for certain classes of goods.
- 4 It leaves the more or less dependable field of book records for a territory where estimate plays a considerable part.

**NORMAL OR BASE STOCK METHOD**—Concerns using this method assume that a minimum amount of raw materials and supplies must be carried at all times as a reserve to meet production and customer needs. This minimum stock is valued at long-run "normal" prices and may be carried as a fixed asset while the inventory in excess of the base stock is priced on some other basis, usually cost or market whichever is lower. The theory underlying this method is that the base or normal stock is analogous to plant assets representing in effect a fixed commitment of capital and should be valued accordingly. The particular items making up the inventory it is admitted, are constantly changing but the value, it is held, remains undisturbed as long as the volume of goods is maintained at the normal level.

The base stock plan is supported in the smelting, tanning, and oil refining industries on the ground that earnings from year to year are more uniform and stable than under other methods. This is illustrated in Fig. 27, adapted from an article by Peloubet (NACA Year Book, 1936).

**Contrast With Last In First Out Basis**—The difference between the base stock and last in first-out methods has been stated by Graham (NACA Bulletin vol. 18) as follows:

The "last in first out" principle has been likened to the "base stock" or "base inventory" method of valuation, the purpose of which likewise is to assure that the revenue produced from high sales prices is burdened with the costs which cause the high sales prices. The "base stock" method however approaches the problem by way of ascertaining a normal inventory stock and the "low price level" at which the stock is to be valued. In Fig. 26 you will find the "year to date" method adopted by the American Petroleum Institute. You will note that the quantity is basic for a one year period only and that the inventory price is adjusted by averaging (1) the excess of the production and purchases over the sales volume and (2) the volume on hand at the beginning of the year. Thus it is seen that in

	Units	First In First Out		Normal Stock	
		Price	Amount	Price	Amount
<b>FIRST YEAR</b>					
Sales	2 500 000	21¢	\$525 000	21¢	\$525 000
Cost of Sales	2 500 000	16¢	400 000	20¢	500 000
Profit			\$125 000		\$ 25 000
Cost of Sales					
Inventory—beginning	1 000 000	10¢	\$100 000	10¢	\$100 000
Purchases	2 500 000	20¢	500 000	20¢	500 000
Total	3 500 000		600 000		600 000
Inventory—end	1 000 000	20¢	200 000	10¢	100 000
As above	2 500 000	16¢	\$400 000		\$300 000
<b>SECOND YEAR</b>					
Sales	4 500 000	10 5/9¢	\$475 000	10 5/9¢	\$475 000
Cost of Sales	4 500 000	12 2/9¢	550 000	10¢	450 000
Profit or Loss			\$ 125 000*		\$ 25 000
Cost of Sales					
Inventory—beginning	1 000 000	20¢	\$200 000	10¢	\$100 000
Purchases	4 500 000	10¢	450 000	10¢	450 000
Total	5 500 000		650 000		550 000
Inventory—end	1 000 000	10¢	100 000	10¢	100 000
As above	4 500 000	12 2/9¢	\$550 000		\$450 000
<b>THIRD YEAR</b>					
Sales	4 500 000	10 5/9¢	\$475 000	10 5/9¢	\$475 000
Cost of Sales	4 500 000	10¢	450 000	10¢	450 000
Profit			\$ 25 000		\$ 25 000
Cost of Sales					
Inventory—beginning	1 000 000	10¢	\$100 000	10¢	\$100 000
Purchases	4 500 000	10¢	450 000	10¢	450 000
Total	5 500 000		550 000		550 000
Inventory—end	1 000 000	10¢	100 000	10¢	100 000
As above	4 500 000	10¢	\$450 000		\$450 000

\* Indicates a negative figure

FIG 27 Comparison of Normal Stock and First In First Out Methods

those years in which the quantity increases a new basic volume and price adheres. This differs from the "base inventory method" as that method maintains a "normal" inventory stock and price for a longer period than one year.

**Advantages of Base Stock Method**—Advocates of the base stock method claim it may be used to advantage in those process manufacturing industries having the following characteristics:

- 1 When raw materials being produced are basic and homogeneous
- 2 When the cost of finished product is made up largely of some basic raw material as hides, crude oil, nonferrous metals, etc.
- 3 When there is a relatively long period of processing and it is necessary to keep a constant minimum of raw materials in process.

Under these conditions, the advantages of the base stock method may be summarized as follows:

- 1 Less work is involved in computing inventory values at the end of the accounting period, since base or normal stock values are fixed.
- 2 Net income is computed from the long run viewpoint and as a result is more stable.
- 3 Inventories are shown on the balance sheet at a very conservative value.

**Objections to Base Stock Method**—Many accountants, bankers and business men are opposed to the base stock method of valuing inventories. Some of the objections are as follows:

- 1 Balance sheets show inventories grossly understated and are misleading as to the working capital position.
- 2 Profit and loss statement is misleading and contrary to fact since it fails to recognize gains and losses on inventories.
- 3 Base stock is not a fixed asset any more than a minimum bank balance is a fixed asset. There is no similarity in investment in plant and investment in inventory. The former is fixed and for use, while the latter is frequently changing and is for sale.

**SELECTION OF MATERIAL PRICING METHOD**—No one method of pricing requisitions can be used uniformly in all industries. In fact two or more methods may be used to advantage in some industry, and in some cases an individual company may find it necessary to use more than one procedure in costing issues of materials. Thus for example Armour & Co. in its 1941 Annual Report to stockholders reported that it employed the last-in first-out method for the valuation of certain of its inventories, while other inventories were valued in the usual way. In the selection of a method many factors have to be considered, some of which are as follows:

- 1 Kind of industry
- 2 Frequency of material price fluctuations
- 3 Relative value of material entering into manufactured product
- 4 Length of inventory turnover period
- 5 Quantities of material to be handled
- 6 Need for reflection of current prices in cost figures
- 7 Desire to maintain uniform accounting practice in particular industry

A study made in 1937 by the Research and Service Department of the National Association of Cost Accountants shows that there is con-

siderable variety in the methods used in pricing material requisitions. The results of this investigation are tabulated below.

#### METHODS USED IN CHANGING RAW MATERIAL INTO PROCESS

Method	No of Companies	% of Total
Average cost basis	95	45.4
First in first out basis	57	27.3
Standard cost basis	42	20.1
Actual cost basis	9	4.3
Last in first out basis	5	2.4
Highest cost first	1	.5
	<u>209</u>	<u>100.0</u>

A current check up probably would show a greater drift toward the last-in first-out basis or some modification of it.

A bulletin published by the War Production Board for the War and Navy Departments entitled "Explanation of Principles for Departmentalization of Costs under Government Contracts" permits any inventory method representing sound accounting practice. It states:

Materials, parts and supplies withdrawn from stock should be priced in accordance with the inventory method customarily used by the contractor, provided that such method is in accordance with sound accounting practices and is permitted or recognized by governmental agencies such as the Bureau of Internal Revenue and the Securities and Exchange Commission. Among such inventory methods may be mentioned:

- (a) First in, first out
- (b) Last in first out
- (c) Average costs
- (d) Standard costs
- (e) Specific purchase prices

**COST OR MARKET, WHICHEVER IS LOWER**—This method of valuation is a combination of the actual cost and replacement cost plans. It is the basis of valuation used by most accountants and is interpreted to mean actual cost or replacement cost, whichever is the lower. The term "market" or replacement cost is defined by the Bureau of Internal Revenue as "the current bid price prevailing at the date of the inventory for the particular merchandise in the volume in which usually purchased by the taxpayer." It should be observed when this basis is used that "the market value of each article on hand at the inventory date shall be compared with the cost of the article, and the lower of such values shall be taken as the inventory value of the article." Accordingly when inventory is taken, it is necessary to use a form having two columns for unit prices and one column for extensions. Care must be exercised in applying the lower unit cost in each case. Fig. 13 is an illustration of a form that may be used when pricing inventory at cost or market, whichever is lower.

The theory underlying this plan is that, if replacement cost of inventory is less than actual cost, competition will require an adjustment in the sales price and provision should be made for such probable future losses. This method takes into account unrealized losses and excludes unrealized profits. The chief advantage of the cost or market rule is that it is conservative. It is recognized by the Bureau of Internal Revenue.

due in valuing inventories for income tax purposes, and is approved by most accountants and business men. In a study made in 1937 by the Research and Service Department of National Association of Cost Accountants (NACA Bulletin, vol 18), 87.3% of the companies reporting used cost or market, whichever is lower as a basis for valuation.

Much has been written in recent years on the inadequacy of the "cost or market" basis. Use of this method of valuation often gives different results depending upon the concepts of "cost" and of "market" actually employed. Donaldson (NACA Bulletin, vol 15) has expressed the situation as follows:

In the writer's fourteen years of practice as a public accountant he has reviewed hundreds of inventories in many and varied industries and has found that the concepts of "cost" and of "market" actually employed are widely diverse so much so that thousands, even millions of dollars higher or lower would result in using one concept as against another. Practices followed in one enterprise in an industry are quite dissimilar to those of another enterprise in the same industry. Each contends that its concept of pricing is correct and the other wrong. Some companies are decidedly conservative and keep values as low as they dare deducting reserves against inventory for all sorts of contingencies; others lean toward liberal almost inflated valuations. Yet both companies can with logic defend their prices as representing "cost" and "market." Public accountants have become used to this situation and recognize that a wide zone exists in which prices used may swing and still be acceptable as proper in stating that inventories are "at cost or market whichever is lower."

**Objections to Cost or Market Rule.**—Use of the valuation formula of cost or market, whichever is lower is objected to on the grounds that it fails to satisfy both financial and operating interests. The balance sheet logically requires a valuation basis which shows accurately the solvency and soundness of an enterprise. This implies use of the cost or market, whichever is lower method. The profit and loss statement, on other hand, requires a valuation basis that shows the true results of operations which are a measure of the efforts of management. This implies use of the cost basis of valuation. This conflict of emphasis and a method of reconciliation are summed up by Kester (Advanced Accounting) as follows:

The valuation formula of cost or market whichever is the lower while based on conservatism may unnecessarily and improperly burden the current income account. Valuation at cost, on the other hand while placing the profit or loss in the period when realized, may cause the balance sheet to present an entirely inadequate and even misleading story as the basis for credit. For the determination of solvency what the inventory will sell for is of more importance than what it costs or what it will cost to replace. For the balance sheet therefore an inventory valuation based on the selling price is theoretically the proper basis. Conservative treatment must be given this, however. This is accomplished by means of the two accounts "Merchandise Valuation" and "Estimated Profit or Loss from Sales Valuation of Merchandise Inventory" the former of which is used to change the cost value of the inventory to a net cash realizable basis; the latter though shown in the profit and loss statement to indicate the estimated though not yet realized profit or loss resulting from the use of the net cash realizable value is also—if a profit—shown in the same detail in the net worth section of the balance sheet. If a loss is indicated by it it is merged with Surplus and earned profits of an equal amount are thus prevented from being declared as dividends.



On the balance sheet the account Merchandise Valuation will be added to if the cash realizable value is more than cost and subtracted from if that value is less than cost, the merchandise inventory, both short extended the sum (or difference) of the two being full extended as the effective figure in the balance sheet.

Objections to the cost or market method of valuation come from different sources. The rule seems inconsistent and in general inconsistency is the very antithesis of sound accounting practice. The rule recognizes the significance of market price when a decline occurs but denies the significance of the market when prices advance. Use of a combination rule often means that management is swinging from cost to replacement cost and back again from period to period. At the close of one period use of cost or market, whichever is lower yields substantially a cost figure, in the very next period, perhaps, the result is substantially a replacement cost inventory.

This basis of valuation is not a time saver. All of the difficulties of determining the actual cost, item by item are present and in addition one must deal with the problem of discovering market values or replacement costs, item by item. Furthermore, strict use of the actual cost or replacement cost, whichever is lower sometimes permits recognition of losses unrealized by sale. This happens when goods are held through two or more successive periods and the replacement cost, although still below actual cost has advanced beyond the original figure. This objection is usually met by accountants by defining cost as either actual cost or last inventory value, where the goods are held for two or more periods. As Hatfield says the rule "is in no sense truly conservative" is in the case of a particular concern the cost while lower than market may be much higher than in the case of another concern which has purchased more wisely or fortunately.

**INVENTORY RESERVES**—The purposes for which raw material inventory reserves may be created are shown in a study made by the Research and Service Department of the National Association of Cost Accountants (N.A.C.A. Bulletin, vol 18), and are summarized as follows:

- 1 To reduce cost value standard value or normal value of inventory to market when lower
- 2 To recognize losses due to shrinkage obsolescence and slow moving stock which losses have not been related to specific raw materials
- 3 In anticipation of future losses due to the above causes or to price declines

When perpetual inventory records are kept, and it is desired to show the value of the inventory at an amount lower than cost the simplest method is to use an inventory reserve. Otherwise, if reduction in value is to be reflected in the accounts, detailed entries must be made in the stores records to keep them in agreement with raw materials control. Where losses have been definitely determined on specific units of raw material as in the case of some obsolete or slow-moving stock, adjustments in subsidiary stores records and Raw Materials control account should be made, an inventory reserve being unnecessary.

When an inventory reserve is created, the question arises as to the proper treatment of the corresponding charge. Referring again to the

study made by the Research and Service Department of the National Association of Cost Accountants it was revealed

that there is little agreement on the proper treatment of the charge at the time an inventory reserve is set up. Cost of sales is charged to reduce the inventory from cost to market to take care of losses due to shrinkage, obsolescence and slow moving stock and to make adjustments for the difference between the book inventory and the physical inventory. Manufacturing cost and thus the inventory is charged for all those purposes except the last and in addition to provide against losses from price declines. Profit and loss is charged for all of the same purposes as the other two.

The results of the above study indicate a wide difference of opinion as to the proper treatment of the offsetting charge to inventory reserves. To secure uniformity, Howell suggests following list:

1. Is the provision being made for a loss or for an expense which can be capitalized in inventory? Unless the cost represents a proper addition to the valuation of goods in process and finished goods it should not be charged to manufacturing cost.

2. Is the provision a responsibility of the manufacturing division or of the general administration? If a responsibility of the manufacturing division a charge to cost of sales would seem to be justified, if a responsibility of the general administration a charge against profit and loss is in order.

**Types of Inventory Reserve Plans.**—Various types of inventory reserve plans have been widely publicized in recent years. The following material is adapted and in part quoted from Fiske (N. A. C. A. Bulletin, vol. 19). He classifies these plans and summarizes their possible effects:

1. One group of procedures is based upon an underlying philosophy that profits should be so defined as to exclude price gains. Such companies usually report their net income exclusive of both price profits and price losses.

2. A second group of companies recognizes the financial aspects of the problem but seeks a solution through a method which still permits of the inclusion of price gains and losses in reported net income.

Another classification of the plans is possible: those plans which attempt to meet the problem through use of appropriated surplus reserves set up on the liability side of the balance sheet and those which value inventories on bases other than the conventional cost or market whichever is lower. (Examples are the base stock or normal stock method and the last in first out basis.)

**Effects of Inventory Reserve Plans on Profit and Loss Statements.**—The effects of these plans fall into three groups, according to Fiske (N. A. C. A. Bulletin vol. 19):

1. Price gains and losses are excluded from profits. Unless specifically segregated no indication of effect on profit and loss statement appears. This group includes base stock and last in first out bases, which produce their effect directly on cost of sales. During periods of rising prices income is decreased and vice versa during years of declining prices.

2. Additions to surplus reserves are shown as deduction on profit and loss statement before deriving net income. Charges against reserves do not appear unless specially segregated since their effect is to reduce cost of sale.

3. Reserves created as a direct surplus appropriation. In this way income is increased in bad years and is not reduced in good years. During

latter period income includes price profits due to rising prices but in bad years inventory losses are charged against the reserve. Method is therefore objectionable for these reasons. Consistency in reporting net income either as including or excluding price gains and losses would seem to be the minimum requirement.

**Effects of Inventory Reserve Plans on Balance Sheet**—These effects have been discussed by the same authority cited above as follows:

Under the plan followed by the National Lead Company the single inventory figure reflects two valuation bases. Minimum or normal quantities are valued at a minimum or base price and the excess over normal is valued at cost or market whichever is lower. The result is an inventory markedly different from current general practice. Since the prices used to value the minimum stock are set very low the effect is to decrease apparent working capital in years of higher prices. Also balance sheet comparisons with companies using other plans become extremely difficult. Balance sheet ratios are affected, in particular the inventory turnover ratio loses most of its significance.

Best of all the plans from the balance sheet point of view would appear to be those followed by the American Smelting & Refining Company by the Plymouth Cordage Co., by Goodyear Tire & Rubber Co. and by the Endicott Johnson Corp. These companies value inventories in the current asset section at cost or market whichever is lower, but set up on the liability side of the balance sheet a reserve to revalue the inventory down to the desired levels. This procedure provides full disclosure, makes the balance sheet directly comparable with balance sheets of other companies and states working capital at current prices. At the same time it provides the management with all necessary information for sound financial policy.

A possible exception to the last plan is the effect it produces on the working capital ratio by displaying the complete inventory as a current asset and providing a reserve on the liability side below the current liability line. It may be better to adopt a scheme similar to that used by the International Harvester Company and U. S. Steel Corporation. These are among companies which have revalued inventories on some basis other than cost or market. Both these companies have at times created valuation reserves bringing net inventory below cost or market whichever is lower.

## SECTION 14

### SCRAP, WASTE, AND SPOILAGE

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## SECTION 14

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### SCRAP, WASTE, AND SPOILAGE

#### Treatment of Scrap and Waste

**DEFINITION AND CLASSIFICATION OF SCRAP**—The terms scrap, waste, defective work and spoilage are often used indiscriminately in everyday language. The following definitions are generally accepted by accountants:

Scrap consists of fragments or remnants of material that remain after certain manufacturing operations or processes have been completed, and that have some monetary or use value. It is a form of raw material that may be sold in the open market, used as raw material in manufacturing operations, or used as supplies in various departments of a plant.

Scrap is brought into existence in metal industries through the operations of cutting, boring, punching, turning, etc., in woodworking plants by sawing, shaving, trimming, etc., in leather and garment manufacturing industries through cutting and trimming operations.

Carroll (N.A.C.A. Bulletin, vol. 18) has classified scrap from a functional viewpoint as follows:

1. **Legitimate scrap**—Scrap which is predetermined or anticipated at the time costs are estimated, i.e., foundry spile and shagbays, mill turnings, borings, etc.
2. **Administrative scrap**—Scrap resulting from obsolescence of design, because management wishes to withdraw the article from the sales field or for some other reason.
3. **Defective scrap**—Scrap resulting from poor base materials, poor workmanship, or some other reason which makes the article unfit for sale.

**DEFINITION AND SOURCES OF WASTE**—Waste as contrasted with scrap is often considered as having no value and is treated as a loss. According to Greer (N.A.C.A. Bulletin, vol. 17), waste is "the portion of a basic raw material lost in processing, having no recoverable value." Thus, the only difference between scrap and waste according to this school of thought, is whether the residue has some value or no value.

On the other hand, the terms **scrap** and **waste** are frequently used interchangeably. For example, the following definition of these two terms is found in Amidon and Lang (Essentials of Cost Accounting):

Waste or scrap may be defined as small pieces of material which cannot be utilized for the purpose originally intended but from which some recovery may be had.

Waste is the result of manufacturing, operations and may arise under the following conditions

- 1 Fragments or remnants of basic raw materials left over as in the case of scrap but which cannot be sold in the open market or used in any manner
- 2 Disappearance of a basic raw material in the manufacturing process through evaporation dust smoke, gas etc

According to Rohrbach (Proceedings International Congress on Accounting, 1929), waste divides itself logically into

- 1 Waste which is made and may be put back into the process (used a second time)
- 2 Waste which may be transferred and prepared for sale to some particular customer
- 3 Waste which disappears through evaporation or is blown into the air
- 4 Waste which is valueless being in the nature of sawdust sand grit, or dirt

The American Society of Mechanical Engineers has published a **Waste Materials Dictionary**, which lists five main ways open for the disposal of waste materials

- 1 Reuse as they are or with economical modifications
- 2 Return to the original maker or supplier for cash or credit
- 3 Sale directly or to employees or through dealers to other manufacturers who can use the materials as they are or with economical modifications
- 4 Reclaiming or reconditioning for the same or other uses
- 5 Sale to dealers as scrap or waste

**DETERMINING WASTE QUANTITY**—The measurement of waste is illustrated in the case of a cotton spinning mill by Klimmer (NACA Bulletin, vol 3)

The mill is charged with raw cotton as used and with all operating expenses, and credited with sales of yarn at an estimated cost. The value of waste sold is credited to the mill at its sales price. An inventory is taken at the end of the accounting period and the difference between the quantity of cotton opened plus the beginning inventory of work in progress and sales plus closing inventories of work in progress represents waste which has been a total loss except that some of it may be salable to outside concerns for purposes other than spinning.

A detailed statement of the determination of the quantity of waste is illustrated by the Cotton Textile Institute, Inc (Costs in Cotton Yarn Mills)

	Lbs
Stock in process (beginning)	39 280
Cotton opened	938 000
Total available	977 280
Less stock in process (ending)	41 000
Theoretical yarn production	936 280
Actual yarn production	788 580
Gross waste	147 680
Waste recovery	50 184
Invisible waste	97 496

The value of the waste recovery may of course be found by multiplying the unit value by the number of pounds recovered

**INVISIBLE WASTE**—The disappearance of the material element, which becomes an item of invisible waste, is often a more complicated problem than the waste that can be measured, for the reason that this particular type of waste is not always constant, it may represent a very definite percentage of the total material for a period of time, and then again, it may fluctuate considerably

Special attention to this invisible waste often leads to improvements in the manufacturing operations, e.g., a conveyor system being substituted for a blower system, in transferring the materials from a preparation department to a card room in a textile mill. Additions in the way of humidifiers and oil added in the process have also cut down the waste percentage considerably, and thereby resulted in a more definite control of the materials and eventually to a definite reduction in costs

Where an industry has this problem of invisible waste a waste percentage may be established which is to be used in cost calculations and as a yardstick in measuring operating efficiency. This can only be established after a period of tests properly followed through. It usually cannot be measured or counted in any other way. This test includes following through a definite quantity of basic raw materials from the raw state into the first operating department, definitely keeping count of the basic materials used, obtaining true and accurate records of the production through the first department, listing and classifying the inventory of visible waste on hand, thereby establishing the percentage of waste which has disappeared

**EFFECT OF WASTE ON UNIT COSTS**—The effect of waste is to increase the unit cost of production since the total cost is spread over a smaller number of units produced. The general practice is to include in direct cost the lost value of items scrapped in a process. By this is meant the absorption in the cost of the good units finished of all material labor and overhead less the salvage value of the rejected items. Klinger (*N A C A Bulletin*, vol 3), however, suggests a different technique

A common fallacy in trying to obtain an average cost is to divide the departmental cost by the good production of the department and to total up these operation costs per pound and call it an average cost per pound of finished product

While 300 000 pounds of good laps may have been produced in the picker room in one month assuming that the picker room costs are roughly \$1 200, using the good production of the picker room as a basis the cost would be \$004 per pound. However 75,000 pounds will be waste and only 225 000 pounds of the 300 000 pounds can be realized as finished product in the winding room. This 225 000 pounds has cost \$1 200 to run through the picking operation and consequently the picking cost of yarn wound is \$1 200 divided by 225 000 pounds or \$0053 per pound

The easiest way of overcoming this problem is to base the operation costs on the final good production in the winding room. As far as preventing these abnormal costs from reflecting against the foreman of any department is concerned all that is necessary is to obtain two sets of figures, one showing the total operation cost divided by the good production of the department and the other showing the total operation costs divided by the final winding production. The first one will give a fair basis for judging



the foreman's results and the other represents the average cost per pound of yarn wound

**ACCOUNTING FOR SCRAP**—To some extent the technical differences between scrap and waste give rise to differences in accounting treatment, although there are also present similarities in treatment. The cost of materials used in production is affected by the scrap produced and its treatment on the books. No uniform method of scrap treatment has been worked out. Scrap may be sold or reused as raw material or supplies. According to Amidon and Lang (*Essentials of Cost Accounting*), the following accounting methods are feasible:

- 1 Credit Sale of Scrap
- 2 Credit the particular job or process responsible for scrap
- 3 Credit Manufacturing Expense control also credit the departmental standing order of the department responsible for scrap

**Scrap Sales Account**—In some factories where the amount and value of scrap is negligible no entries are made until the scrap is sold. Under these conditions, production costs are not reduced and the value of scrap is not set up on the books. The entry required when scrap is sold is:

Cash or Accounts Receivable	\$	
Scrap Sales		\$

The latter account is closed to Profit and Loss and usually treated as "Other Income" in the profit and loss statement.

A variation of this scheme is to credit the proceeds from the sale of scrap to a special revenue account, while the cost of scrap sold is charged against it. The balance may be treated as other income as a reduction in material cost, or even as reduction in overhead. Klummer mentioned above, speaks of this method as applicable to a cotton spinning mill.

Charge all reclaiming costs against a reclaiming account and credit all sales from waste to this account. The balance of this account is then credited to general overhead and the net income from waste distributed among the various cotton stocks.

**Crediting Work in Process**—This method as well as the one described above is commented on by Rohrbach (*Proceedings International Congress on Accounting, 1929*). Note that he uses the term waste in the sense of scrap.

The ideal method of accounting for waste which finds its way back into process and can be used again would be to establish a means of counting weighing or measuring the waste to establish a debit and a credit to the process accounts.

Where waste is sold it is of course essential to establish records for reporting the weight count or measure when it is transferred from the operating departments for sale. If there is a steady market for the disposal of this waste it would be advisable to credit the income received from the sale of waste to the particular process or product if this is practicable. If not the income received from the sale of waste may be credited to an item of Sundry Income Sale of Waste, and the entire first cost of the material would be absorbed in the cost no credit being passed for the waste element.

Theoretically the proper value to place on scrap is cost, but since this is practically impossible in most cases, an acceptable procedure is to value scrap recovered either at gross or net salable value, depending upon the amount of expense involved in storing and selling the product. Some organizations value scrap at average market price based on price quotations over several periods in order to equalize costs of different periods. This method is followed in those industries where scrap prices fluctuate frequently.

Where the scrap has no definite market value, an arbitrary cost for the scrap put back into process may be used. This is also the view of Kilmmer (N. A. C. A. Bulletin vol 3) who discusses the accounting for the carding department of a cotton spinning mill. Again the term "scrap" should be substituted for "waste" in the quotation below.

The card room is charged with all labor and expense incurred therein, and credited with the net proceeds from the sale of waste. Some of the waste made from both the carded and combed stock is turned back for use as carded stock. To clear up the accounts it is necessary to credit the carded and combed stocks in the card room and debit the opening room, for the value of waste turned back. However it is hard to fix the value on this waste turned back. To use its cost thus far and credit combed stock in the card room and charge carded stock in the picker room with this amount would be to burden carded costs with an unreasonable charge, since this waste is actually worth less than the new bales of cotton being opened. In most cases therefore an arbitrary price is placed on this cotton turned back which will reflect its comparative value.

The good production of each cotton stock is now divided into the net departmental costs after allowing for sales and reclaimed value of waste, giving a cost per pound to be charged against the following operation.

The steps in obtaining the costs in the picker department, are as follows:

- 1 The opening and picking department is charged with the cost of cotton opened, scrap returned for reuse by other departments, and labor and expense incurred.
- 2 The total charges are divided by the good production for the period, giving an average conversion cost per pound of cotton produced.
- 3 The net cost of carded and combed stock including labor, materials and expense and an allowance for waste sold is applied against the quantity of material transferred to the card room charging this amount to the card room and crediting the picker room.

In this manner any scrap accumulated in this department is absorbed in the average cost per pound of the product. Of course, a record is kept of the quantities of scrap produced. This quantity may be shown on the ledgers if desired by opening a Scrap account, by departments preferably since the quantity of scrap is so very high.

When scrapped materials are removed from the factory to the store-room a scrap report is made out (Fig 1). From a summary of such reports, formal journal vouchers are prepared.

Stores	\$	\$
Work in Process		

The entry is posted in the usual way to the general or factory ledger. At the same time, subsidiary records are posted as follows:

Stores Ledger Enter in "Received" and "Balance" sections of stores card set up for scrap  
 Job Order File Enter in led in material section of job cost sheet

Where a process cost system is used, the posting is made to a departmental process account instead of a job cost sheet. In either case material costs on job or process are correctly stated as a result of the adjustment.

If scrap is returned to stores and can be used as new material, it is charged in at new material price. Tin and zinc ingots recovered from dross are illustrations of this type of scrap. Odd sized pieces of metal are frequently returned to stock at a nominal value, to be used when possible.

**Crediting Manufacturing Expense**—Another method used in accounting for scrap is to treat the sales value as a reduction in the departmental manufacturing overhead. Since it is often difficult to allocate the value of scrap to a particular job, it is credited to the manufacturing overhead of all jobs. The accounting entries for this method are illustrated below.

Raw Materials Control	\$	
Manufacturing Expense		\$
Stores Ledger Post to "Received" and "Balance" sections of stores card set up for scrap		
Standing Order Post to departmental expense account of the department responsible for the scrapped material		

**BY PRODUCT RECOVERY**—To an increasing extent, materials once considered waste are utilized by industry through invention of new products making use of waste materials. Thus, pieces of scrap metal are often used for production of small parts. In such cases, Rohrbach points out, it is simply necessary to allow the scrap to go back into process without any entry at all on the books. That is, no attempt is made to credit direct material for the scrap used, and the small parts are put into production without material cost. Thus a woodworking shop uses scrap pieces for the manufacture of golf tees. The production cost of golf tees is direct labor plus a percentage of burden. (For discussion of by-product accounting see Section 10.)

**SCRAP REPORTS**—Scrap reports differ in content, as shown in Figs 1 and 2. These are used for reporting scrap to the cost department, and production costs are adjusted accordingly.

Fig 1 is a daily scrap report recommended by the National Battery Manufacturers' Association for use by its members. This report is sent daily to the planning and cost departments.

Fig 2 is a combination form for use by the inspector in reporting scrap from production, and in rejecting purchased materials received by the receiving department. Its use may be further extended by letting it serve as authorization for the issue of material replacing the scrapped material. The form is issued in quadruplicate and the copies disposed of as follows:



- 1 Original—General superintendent
- 2 Duplicate—Planning department
- 3 Triphate—Accounting department
- 4 Quadruplicate—Inspection department

In case of material scrapped in production the form provides spaces for determining the unit and total costs of scrap analyzing these into raw material enamel assembly labor, and machine labor

DATE <u>January 18</u>				
REPORT OF SCRAP FOR DEPT. <u>Pasting</u>				
Date	Production	Scrap	%	Remarks
1				
2	69 150	873	0 54	
3	63 729	491	77	
4	49 222	849	69	
5	20 630	140	68	
6				
7	65 887	474	72	
8	59 110	520	88	
9	38 709	239	85	
10	52 578	379	72	
11	47 020	379	70	
12	18 334	125	68	
13				
14	60 706	688	1 10	
15	54 585	513	94	
16	49 345	400	81	
17	51 446	473	92	
18	13 2-2	402	93	
19	21 303	247	1 18	
20				
21	51 031	485	94	
22	48 210	391	81	
23	50 090	376	75	
24	41 167	348	84	
25	47 348	455	96	
26	17 238	116	67	
27				
28	59 861	569	95	
29	46 033	488	1 06	
30	51 975	411	79	
31	40 090	342	84	
Total	1 220 287	10 232	84	

Reverse Side		
Month	Year	%
July	19—	1 04
Aug		99
Sept		1 10
Oct		1 15
Nov		1 03
Dec		1 09

FIG 3 Report of Scrap for Departments

The National Battery Manufacturers' Association recommends that on the basis of daily scrap reports the cost department in turn make a report to the management showing the scrap as percentages against the production of the various departments. This report is in the nature of a card with the current month on the front and the weighted average by months for the year on the reverse side (Fig 3)

**ACCOUNTING FOR WASTE**—Since waste material is assumed to have no value, no accounting entries are necessary. The value of materials wasted is already included in the production costs when direct materials are charged to job orders or to processes. As stated by Klumme, quoted earlier:

The net loss due to waste is absorbed in the accumulated costs per pound as cotton goes through the plant.

This method of accounting may produce undesirable results if the waste is excessive. In those cases where such waste is definitely known, the excess may be removed by a credit to Work in Process account and a debit to an Excess Waste account which is closed to Profit and Loss. Under this treatment the abnormal waste is set forth clearly and production costs include only normal waste cost.

## Defective Work and Spoilage

**DEFINITION OF DEFECTIVE WORK**—Defective work consists of imperfect products which are brought up to standard specifications by the application of additional material or labor, or both. Defective work may be the result of any number of causes, such as poor materials, incompetent supervision, carelessness in planning, poor workmanship, inadequate equipment, laxity of inspection, etc. To be classed as defective work, the product must have additional labor, material, and plant services applied to bring it to the point of perfection. These items constitute reoperation costs incurred in remedying imperfections so that the product meets the required standards of quality.

**DEFINITION OF SPOILAGE**—Spoilage results when materials are so damaged in manufacturing operations that they are taken out of process and disposed of in some manner without further work. Spoiled materials cannot be repaired or reconditioned as is done in the case of defective work. In some cases spoiled work must be sold as seconds as in hosiery manufacturing, but in others it can be salvaged as scrap and either sold or used over again as raw materials in the manufacturing processes. In either case there is not only a material loss in the product but there is a loss also of labor and manufacturing overhead already incurred on the material. Basically, therefore, spoilage is on a par with scrap.

**CLASSIFICATION OF DEFECTIVE WORK**—Rohrbach classifies defective work as follows:

- 1 Defective material items in the raw state, that is, the state in which it is purchased.
- 2 Defective work on the operating floors upon which some labor has been expended.
- 3 Defective finished goods which have been lent in stock too long.
- 4 Defective merchandise returned by customers, not being up to specifications or sample.

**ACCOUNTING TREATMENT FOR DEFECTIVE WORK**—Defective work or spoilage may be disposed of in various ways:

- 1 Sold as scrap.
- 2 Sold as seconds including reworked material for resale.
- 3 Reused as raw material.

The cost of defective work may be treated as follows (Amidon and Lang, *Essentials of Cost Accounting*):

- 1 Treatment by neglect.
- 2 Charging general overhead.
- 3 Charging department responsible.
- 4 Costing reconditioned work.

**Treatment of Defects by Neglect**—In those plants where seconds are normal and have a very nominal value the loss is usually absorbed by the good units completed. This is accomplished by dividing the total cost by the number of perfect units finished. As stated by Amidon and Lang

All that is done is to spread the total manufacturing costs over the good units produced. Thus if 20 000 pounds of castings were poured in a foundry at a cost of \$10 000 and on examination 1,000 pounds were found to be defective, the unit cost would be

$$\frac{\$10\,000}{19\,000\text{ lbs}} = \$526$$

By this method good castings are made to bear in the first instance the entire production cost. The defect of this method is the lack of statistical information through the ledger accounts about losses suffered from defective work.

This plan is followed when seconds or defective goods bring scrap prices or prices slightly in excess of scrap, also when seconds or defectives are produced under normal conditions because of features beyond the control of management.

DEFECTIVE WORK REPORT						
DATE _____			NO _____			
DEPARTMENT RESPONSIBLE _____			STANDING ORDER NO _____			
NATURE OF DEFECTS _____						
CAUSE OF DEFECTS _____						
_____						
DESCRIPTION OF WORK TO BE DONE	DEPT NO	COSTS INCURRED				
		MATERIAL	LABOR		MFG EXPENSE	TOTAL COST
			HOURS	COST		
SIGNED _____						

FIG 4 Defective Work Report

Any recovery to be had from the sale or other disposition of defective work is handled through appropriate revenue accounts

**Charging General Overhead**—The cost of defective work may be charged to a Defective Work account, that is a standing order controlled by Manufacturing Expense on the general ledger. The cost includes all material, labor, and overhead up to the point where the defect occurred. At the end of the cost period, the spoilage cost is prorated to the producing departments along with other general factory overhead. This is apparently the method urged by the National Battery Manufacturers' Association in its Uniform Accounting Manual. It is there stated that defects such as overformed plates, caused by gross carelessness, improper mixing of oxides not discovered until after plates are pasted, etc., are chargeable to Defective Workmanship as overhead expense.

Labor used in disposition of waste is treated as an indirect charge.

**Charging Defects Departmentally**—This is the same as the method above except that defects are charged directly to the department responsible for it, not necessarily the same as the department producing it.

**Costing Reconditioned Work**—When defective work is to be reconditioned, a defective work report (Fig 4) is made out. In this case the cost involved in remedying imperfections is not a cost of the particular job on which the defective work was discovered, but is considered a manufacturing overhead item. Hence, the method followed in accounting for reoperation costs is to charge manufacturing expense on a standing order of the department responsible for defect. The accounting entries necessary are illustrated below.

Manufacturing Expense—Department A	\$	\$
Stores		
Accrued Payroll		
Manufacturing Expense Applied (Various departments)		

Stores Ledger Enter in "Issued" and "Balance" sections of the stores ledger cards for materials required.  
 Standing Order Enter as defective work" on standing order of Department A.

**ACCOUNTING FOR SPOILAGE**—Losses due to spoiled work are production costs and should be charged to the process or job directly, or indirectly through the manufacturing overhead. If the amount of spoiled work occurring during normal operations is negligible and has no value, it is often charged directly to the process or job by dividing total units completed into total cost of job or process. No accounting entries are necessary for spoilage under this situation. The treatment is the same as that described under "Treatment of Defects by Neglect."

The following illustration and comments thereon are taken from Greer (N A C A Bulletin, vol 17) and furnish an example of spoilage cost calculation in a drop forge plant. In this case, the spoilage costs are charged to a specific job order.

On the job covered by the illustration (Fig 5) a lot of 1000 pieces was begun. The first hammer run produced 850 usable pieces 100 pieces which



could be made usable by "restriking" and 50 pieces completely spoiled. The second hammer run completed 100 additional usable pieces.

The upper section of the illustration provides for a separate record of the cost of the 1 restrikes and for the combined cost of the 950 good pieces finally produced. The lower right hand portion of the illustration shows the net cost of the entire job after crediting the salvage value of the scrap for 50 spoiled pieces. This is arranged so as to indicate what the total cost would have been if all the pieces had been good at the first operation, what it was after absorbing the cost of 1 restrikes and what it was after crediting the salvage of the scrap.

The lower left hand section of the illustration is a separate computation of the cost of defective work including both the 1 restrike cost and the net loss on the spoiled pieces. This supplies the significant fact that on this order each piece finished costs  $7\frac{1}{2}$  cents more than it would have cost had the order been completed perfectly at the first run.

**Sale of Spoilage as Scrap**—If spoiled work can be sold at scrap or junk prices or used in some manner in the plant, provision should be made to remove from the Work in Process account all costs incurred up to the point of spoilage (Figs 2 and 4). This is the procedure to be followed in the case of government contracts, a manufacturer is permitted to include the normal amount of spoilage and defective work in the cost of the work performed, due recognition being given for abnormally rapid expansion of production. In the absence of exercise of reasonable care by a contractor, excess spoilage may be limited or excluded from the cost calculation. Government contracts also require that the value of any scrap resulting from war production must be taken into account at proper current scrap prices whether or not the scrap is sold.

Order <u>177</u>	Date <u>March 5</u>	Pattern <u>B 19</u>	No. Begun <u>1 000</u>	No. Finished <u>950</u>				
Item	Unit	Unit Cost	Base Run		Re Strikes		Combined	
			Units	Total	Units	Total	Units	Total
Material	Pc	\$ 18	1 000	\$ 180			1 000	\$ 180
Labor	Pc	26	1 000	260	100	\$ 26	1 100	286
Hammer time	Min	3 00	60	180	5	15	65	195
Set up	Flat	22 00		22				22
				<u>\$ 612</u>		<u>\$ 41</u>		<u>\$ 653</u>
Cost per piece begun				<u>\$ 612</u>		<u>\$ 661</u>		<u>\$ 683</u>
Cost of Defective Work		Total	Pc Fin	Cost of Entire Job		Total	Pc Lin	
Re strikes (as above)		\$41 00	\$ 043	Base run cost (as above)		\$612	\$ 644	
Spoiled				Re strikes		41	043	
50 pcs @ \$ 012 ea				Total		\$653	\$ 687	
Salvage @ .060 ea				Less Salvage value of scrap (50 x \$ 08)		4	004	
Net cost	<u>\$ 587 ea</u>	<u>26 60</u>	<u>028</u>	Net cost of order		<u>\$640</u>	<u>\$ 683</u>	
Total cost of defective work		<u>\$87 60</u>	<u>\$ 071</u>					

FIG 5 Spoilage Cost Calculation

The above treatment is essential so that the cost of good work done is not overstated. It also prevents overstatement of Work in Process. The accounting entries under this condition based upon a spoiled work report are as follows:

Manufacturing Expense—Department A	\$
Stores	
Material in Process	\$
Labor in Process	
Manufacturing Expense in Process	

To relieve Work in Process of the spoilage cost and charge scrap value to Stores balance of scrap cost is charged to overhead.

The subsidiary ledger postings are as follows:

Standing Orders Enter on standing order of the department responsible for the spoilage under 'Spoiled Work'.  
 Stores Ledger Enter scrap value in 'Received' and 'Balance' sections of a stores card set up for scrap.  
 Cost Sheets Enter proper credits on cost sheet or in departmental process account if process costs are used.

Under this method only the unrecoverable portion is charged to expense, while salvage is charged to an asset account as inventory.

In those cases where only a few parts are spoiled on a production order and it is desired to complete the good parts, it is necessary to apportion the costs incurred to date between units spoiled and good units (Fig. 5).

In the hosiery industry, the spoiled product may be in the nature of seconds, thirds, etc., which may be sold in the open market. The chief problem in connection with this type of spoiled or defective work is one of valuation. In order to evaluate such products a number of different methods have been advanced, the most common of which are as follows:

1 Value the seconds, thirds, etc., at actual cost and take the loss at the time goods are sold. This method overvalues defective articles carried in stock, making it necessary to adjust for loss on inventory when statements are made.

2 Value the seconds, thirds, etc., at sales price after deducting a percentage for selling and administrative expenses. The difference between the total cost of producing all grades and the estimated net sales value determined above is charged to a Spoiled Work account which is considered as a part of manufacturing overhead. This in effect increases the cost of producing the first grade products. Obviously no profit is shown on seconds and thirds under this method of treatment.

3 Value the seconds, thirds, etc., at their selling price less the percentage of gross profit realized on the sale of first grade articles. For example, if the gross profit percentage on firsts is 40% and the sales price of seconds is \$1.00, the seconds are valued at \$.60 each. Under this method the firsts bear a larger share of the cost in that the loss on spoiled work is increased, but a profit on the sale of inferior goods may be shown.

The last method is described by Mogel with reference to a hosiery mill (N. A. C. A. Bulletin, vol. 13). The cost of manufacturing imperfect merchandise is the same as for first quality, and in some cases is appreciably greater. The products regardless of quality, pass through identi-

cal operations and are finally graded at the end of the productive operations. At this grading or inspection, reports are made to show quantities of each quality in a particular lot. In the full-fashioned hosiery industry there are the grades of "imperfects," "seconds," "thirds," "fourths," "rags."

The inventory value of all substandard grades is determined by apportioning commercial and packing expenses on the basis of their standard relative market values and subtracting the apportioned expenses from the standard market values. The result is the standard inventory value of each substandard grade.

### Scrap and Spoilage Standards

**PREDETERMINATION OF SCRAP**—When the amount of scrap obtained from manufacturing processes can be determined in advance with a fair degree of accuracy, the cost of raw materials issued may be adjusted at the time materials are moved to the factory from the storehouse. The example shown below is from Green (N.A.C.A. Bulletin, vol. 17) and illustrates how such adjustments may be predetermined in the case of a woodworking plant where cutting operations result in the salvage of three types of items:

- 1 Usable lumber in small sizes which may be returned to stock and reused for the production of other articles
- 2 Scrap lumber not usable in production but salable for kindling or otherwise
- 3 Sawdust, salable or usable as fuel in the plant

#### COST ADJUSTMENT FOR SCRAP VALUE IN FURNITURE FACTORY

Total value of new lumber drawn from stock during period	\$14 310 20
Value of materials recovered	
Usable lumber returned to stock (at market)	\$1 027 18
Scrap pieces salable for kindling etc. (at sales value)	88 60
Sawdust	27 20
	<u>1 142 98</u>
Net cost of lumber used in production (91.8% of total value new)	<u>\$13 167 22</u>

For standard material charge on new lumber use 91.8% of cost; other inventory credits to come from scrap credits. Variances may be checked to determine percentage scrap recovery value.

**SPOILAGE CONTROL THROUGH STANDARDS**—Relatively new is the attempt to control spoilage by the use of standards. A manufacturer of brass products reports that in preparing standards a standard allowance is provided for spoiled work and for extra operations for each product to be manufactured. These standard allowances are charged directly to Cost of Sales and all extra costs for reoperations over and above these allowances are then shown as a separate item on the cost of sales analysis. In this way they stand out as a danger signal calling the attention of management to the need for corrective action.

Typical of another attempt at spoilage control through standards is that of a rubber company whose scrap control plan is set forth by Wynn

(NACA Bulletin, vol 16) Speaking of the scrap account, Wrinn states

Moving next to the scrap account note that this account is charged with the standard value of all scrap actually produced, less its standard salvage value and the account is credited with standard allowance for scrap in goods finished. The balance then goes to the penalty (variance) accounts. Note here that we carry no inventory balance. Hence if more goods are processed than finished the true efficiency on scrap is not reflected in the current month although over a period the differences are negligible.

The same authority explains how material scrap standards are set.

Standard patterns form the basis from which part costs are built up. Taking these patterns we lay each one out individually in order to obtain its net area and gross area. Having the area we convert it into cents of direct material and cents of scrap from the formula costs and square yard costs already figured.

In the same way scrap labor allowances are separated from direct labor allowance. A burden scrap allowance is also provided for. In operating the Work in Process accounts the usual debits at standard are made to Work in Process. According to Wrinn the credits are as follows:

- 1 Develop the standard cost of goods finished by extending the units produced by the unit standard cost subdividing this into:  
Material material scrap labor, labor scrap labor setup, burden burden scrap and depreciation
- 2 Cost all scrap produced during the month at standard
- 3 Cost all other variations from standard in like manner

**DEPARTMENTAL SCRAP CONTROL STANDARDS**—An excellent illustration of standard cost approach to scrap control is provided by Lause describing the method used by an automobile manufacturer (NACA Year Book 1935). Lause states:

We decided that we would set standards of scrap and reoperation costs for each division and department of the plant, determine the responsibility for scrap and reoperations by departments and keep up a record in figures and graphically as well of each department's performance in relation to its predetermined standard, and hold meetings at regular intervals to review the performance.

**Placing Responsibility for Spoilage**—This company measures scrap costs on the basis of the direct labor dollar. The reason for selection of this base was convenience.

As a matter of fact direct labor was the measuring stick most available. After all the payroll has to be computed and paid in our case weekly and since we wanted to hold weekly sessions to review performance, direct labor lent itself most readily to our plan.

The scrap control section secures the signature of the foreman admitting his responsibility for scrap. Where the foreman refuses to sign the scrap ticket, he submits his reason.

His explanation may involve another department and that foreman is then contacted. In some cases several departments are involved and where this occurs a meeting is called by the scrap control section the case is reviewed and the responsibility determined. Sometimes a compromise

results and the responsibility is split. Should the meeting result in a deadlock the case is then reviewed and decided by the supervisor, a member of the factory manager's staff in charge of the particular group of products or operations on which the spoilage occurred.

**Setting Standards**—Costs are charged to the department responsible for spoilage. Each productive department's scrap is measured against its direct labor and scrap caused by service departments is measured in terms of the direct labor of the entire plant. Scrap standards are set by the scrap control section which reviews each product and develops a unit standard scrap cost. This unit scrap standard is built up in two ways:

- 1 Percentage of quantity of scrapped product to quantity of good production
- 2 Unit cost of scrap to be added to the cost of good product

In the case of products in continuous production from year to year, the standard is based on experience. This represents the best performance maintained for a reasonable length of time. Abnormal conditions are left out of consideration. In the case of new products, comparisons are made with similar products or classes of products and differences of design and specifications are allowed to influence the standard upward or downward, as the case may indicate.

The following steps are necessary in setting scrap standards:

- 1 Obtain unit scrap standards by departments
- 2 Obtain forecasted standard departmental scrap cost for the year by multiplying the unit cost by the forecasted production of each product
- 3 Reduce total departmental scrap cost to a per cent of direct labor

**Forms Used in Gathering Information**—The following forms are used in gathering information on scrap:

- 1 Scrap or salvage ticket (Fig 6)
- 2 Daily scrap reports
- 3 Weekly scrap reports
- 4 Monthly scrap reports

**Scrap and Salvage Ticket**—The inspection department makes out a scrap ticket in five copies (Fig 6). Lause states:

Separate scrap tickets are made up for each part, and if scrap occurs for several different causes on the same part or product a scrap ticket is made out for each cause. Then too if rejections occur on the same product for the same cause but the rejections take place after different operations separate scrap tickets are made out.

The writing and distribution of the scrap tickets for each day's scrap is completed by ten o'clock on the morning of the following day. The five copies are used as follows:

The original standards department copy, is delivered by the inspection department to the cost department where the cost of the scrap described on the ticket is entered in the space provided. The ticket is then delivered to the standards department whose job it is to determine the responsibility for the scrap.

The second payroll department copy accompanies the original until the responsibility is determined. When the responsibility has been fixed the foreman if he knows that the operators carelessly caused the scrap marks this copy "Do not pay Group No \_\_\_\_\_" in the space provided.

STANDARDS DEPT COPY

5795

**SCRAP TICKET**

Part No <b>751790</b>	Part Name <b>Westinghouse Motor Mounting</b>	
Dept Responsible <b>12</b>	Last Oper No <b>15</b>	Last Oper Name <b>Assemble</b>
Quan Rejected <b>40</b>	Date <b>4-26</b>	DO NOT PAY GROUP <b>12-8</b> Foreman's Initials <b>W. P.</b>

**CAUSE OF SCRAP****Wrong Insert Assembled.**

Stamp here when salvage

Insp **A. H.**Foreman **W. Protsman****RESPONSIBILITY BY STDS DEPT****Stock Preparation - Protsman.****COST EXTENSION**

	Quan	Unit Cost	Amount
<b>Material</b>	<b>40</b>	<b>.02013</b>	<b>81</b>
<b>Labor</b>		<b>.01609</b>	<b>64</b>
<b>Burden</b>		<b>.02111</b>	<b>84</b>
<b>TOTAL</b>			<b>2 29</b>

TRU PAK Therry Regl Ser Co D 350 CH

FIG 6 Scrap or Salvage Ticket

This second copy then goes to the payroll department for adjustment of its records with regard to group payment.

The third the foreman's copy is delivered by the inspection department to the foreman whose department in the inspector's opinion is responsible. Received as it is before noon of the following day it gives the foreman a daily report of his performance early enough to assist him in making decisions with regard to the correction of his operators' equipment or methods in eliminating the cause of such spoilage in the future. All of our foremen use this copy. They have become accustomed to figuring daily the percentage of scrapped pieces to O.K. production in their department at least on major volume jobs and in this way keep themselves conversant with their performance from day to day.

The fourth copy is delivered to the production control department and then to the materials control department for adjustment of their process inventory records.

The fifth copy is attached by the inspector to the parts or products rejected.

Rejected parts are moved to the foremen's office for examination. The cost department enters the unit scrap costs and salvage values on tickets and calculates the total values involved.

**Daily Scrap Reports**—Scrap tickets are sorted by classes of products, and under these classes by parts. The report is made up for each product showing:

- 1 Quantity scrapped
- 2 Quantity of good production
- 3 Percentage of scrap to good production
- 4 Analysis of causes of spoilage

Copies of the report go to the foremen and general management. Daily reports on any product are discontinued as soon as its actual performance day after day comes into line with its standard.

**Weekly Scrap Report**—The cost department prepares a weekly report by resorting scrap tickets according to departments responsible (Fig. 7).

**Monthly Scrap Report**—This is a summary of the scrap cost on each product without regard to responsibility. The report shows actual and standard unit scrap cost and variance.

**Control Records**—The weekly figures are posted by the scrap control section to the departmental scrap records (Fig. 8). The same information is plotted on a chart (Fig. 9).

**Reoperation Costs**—Control of reoperation costs follows lines of scrap control. The company in question does not use a separate rework ticket but the department responsible for rework costs is charged on the basis of the cost department's report.

**Results of Control**—Fig. 10 shows scrap and reoperation costs before and after the control plan was put into force. According to Laue:

In 1930 the year before the control plan was started, we spent \$206,800 for scrap and reoperation on a direct labor of \$395,000 or \$524 per dollar of direct labor. In the succeeding four years and five months under the control plan we have spent \$355,000 for scrap and reoperation on a direct labor of \$2,800,000 or at \$127 average scrap and reoperation cost per dollar of direct labor, a reduction of 75.8%. The saving in scrap and

## SCRAP COST BY RESPONSIBILITY—WEEK ENDING APRIL 3 19—

Responsibility Foreman	Division	Direct Labor	Scrap Cost	Unit Scrap Cost Per Dir Labor Dollar	Standard Unit Scrap Cost Per Dir Labor Dollar	Variance From Std Week End 4/3	Variance From Cum 8/1 4/3
MANUFACTURING DIVISION							
T Jones	Rubber Mill—Antenna—1141 X	\$	\$	\$	\$	\$	\$
	Rubber Mill—Durrone						
	Rubber Mill—Brake Hose						
	Rubber Mill—Brake Hose						
	Compound—Rubber Mill						
	Uncured Treadings—Run Boards						
W Zahn	Running Boards						
	Running Board Inserts						
C Allen	Misc Finish						
	Antenna Assembly						
H Kelly	Brake Hose						
V Telle	Rubber Wheel						
B Fisher	Machine Laboratory						
G Jones	Central Laboratory						
	Mfg Div Not Determined						
	Misc. Manufacturing						
	Total MANUFACTURING DIVISION	\$ 54 533 03	\$ 3 777 80	\$ 00559	\$ 00700	\$ -103 05	\$ - 3 703 25
		\$	\$	\$	\$	\$	\$
	Engineering Division						
	Material Division						
	Sales Division						
	Inspection Division						
	Plant Not Determined						
	Total WEEK ENDING APRIL 3 19—	\$ 54 533 03	\$ 4 594 76	\$ 00552	\$ 00560	\$ 50 53	
	Total Cum Cas Month Year 8/1 4/3	\$1 500 228 05	\$142 938 44	\$ 09 81	\$ 09 60		\$ -17 559 05

[Detailed figures purposely omitted]

Factory Accounting Dept

FIG 7 Weekly Scrap Report



## SCRAP RECORD 19\_\_

Date Week Ending	Direct Labor		Actual Scrap Cost		Scrap Per Direct Labor Dollar		Standard Scrap Per Direct Labor Dollar	Standard Scrap Cost		Variance	
	Week	Cum	Week	Cum	Week	Cum		Week	Cum	Week	Cum
Jan 5	\$1 702.84		\$ 49.18	\$195.76	\$ 027	\$ 031	\$ .04	\$71.63	\$ 138.03	\$32.50	\$ 33.92
12	2 200.49	\$ 3 993.43	76.35	240.99	035	039	.04	88.00	240.72	1.42	0.43
19	2 151.37	6 144.80	114.63	356.86	038	039	.04	86.04	340.92	-28.49*	4.07
26	2 550.55	8 695.35	96.96		.041			95.30		-1.86*	
Feb 2	2 229.64	10 754.99	82.29	419.24	037	039	.04	90.16	430.08	6.77	10.84
9	2 245.51	13 004.50	11.81	4.10	005	033	.04	89.96	320.04	73.15	88.99
16	2 192.79	15 197.29	69.12	500.17	032	033	.04	87.08	607.72	18.66	107.59
23	2 185.87	17 383.16	36.78	536.96	017	031	.04	57.40	693.12	59.63	153.17
Mar 2	2 093.46	19 476.62	37.39	574.34	018	029	.04	83.72	778.84	46.33	204.50
9	2 354.66	21 831.28	39.39	613.73	017	028	.04	94.16	873.00	54.77	259.27
16	2 397.14	24 228.42	57.86	671.59	024	028	.04	95.83	968.83	88.02	347.29
23	2 397.94	26 616.36	65.25	736.84	020	028	.04	91.43	1 060.26	26.23	373.52
30	2 065.83	28 682.19	33.17	775.01	013	027	.04	82.60	1 142.86	44.43	367.95
Apr 6	1 914.39	30 496.58	39.73	814.74	071	027	.04	76.56	1 219.52	36.93	404.78
13	2 179.85	32 676.43	27.87	842.61	013	026	.04	87.16	1 306.68	59.29	464.07
20	2 193.03	34 870.46	40.66	883.27	019	025	.04	87.50	1 394.43	47.14	511.21
27	2 114.58	36 985.04	41.67	924.94	070	025	.04	84.36	1 478.04	42.91	554.12

\* Loss

FIG 8 Departmental Scrap Record



reoperation during this four and one half year period amounts to approximately a million dollars under the 1930 performance, an annual saving of about \$220 000.

As shown by the chart our standard in the first year of control 1931 provided for a 50% reduction. The standard was beaten the actual cost being only \$188 on the standard of \$25. In 1932, the standard provided for another drop of 50% from the previous year's return the new standard being set at \$9.9 which we did not reach. Our best performance was in 1933 when the actual amounted to \$106 on a standard of \$10. Since 1932 we have never quite reached our goal. Our 1935 standard is \$10 and so far we have operated at \$114. Fifteen of twenty one departments are operating within their standards, six are not.

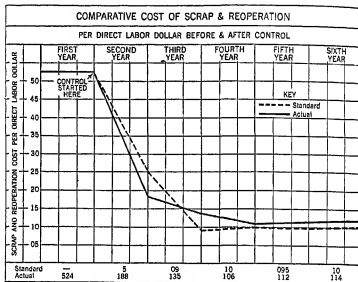


FIG 10 Effect of Cost Control on Scrap and Reoperation Cost

**Cost of Spoilage Control**—Lause in the article referred to stresses the economy of system as follows:

To my mind the surprising part of the control plan is its low cost of operation. A scrap record of some kind would have to be made out in any case and the slightly more detailed method of reporting the information requires no more than about four hours additional per day for the inspection department clerk. One man in the cost department does all the ticket pricing and the making of the weekly report. Approximately one day per week will cover the additional time spent by a comptometer operator and typist. Two men are employed in the standards department on this work of responsibility fixing and the making of reports and charts. The entire clerical cost of the control will not exceed approximately \$7 500 annually, which is only 3% of the resultant saving.

By controlling spoilage, quality control is also obtained. The cost referred to above checks very closely with the figures presented by Whisler for a cash register manufacturer (N A C A Bulletin, vol 18)

	1934	1935	1936
Parts made (000 s)	223 750	213 000	333 022
% scrap loss of manufacturing cost	1 %	¾ %	¾ %
% inspection cost of manufacturing cost	¾ %	¾ %	¾ %

**REOPERATION COSTS**—Carroll presents the salient features of plan for scrap and reoperation control (N A C A Bulletin, vol 18) Scrap inspectors upon receiving rejected production, act as follows

- 1 Investigate cause
- 2 Place responsibility against specific department
- 3 Investigate possibility of salvage by reoperation

**Procedure for Reoperation**—If salvage is possible the inspector makes out a C D S ticket (Changes, Defects, and Shortages, Fig 11) in quadruplicate

The original copy accompanies the goods through the necessary extra operations into the packing room

The duplicate copy is sent to the accounting department for follow up on the accounting for the extra costs involved

The triplicate copy is sent to the superintendent's office for the purpose of advising of the incident the cause thereof the disposition made by the scrap inspector and also to have the superintendent's office take steps to prevent if possible, the recurrence of that particular deficiency

The quadruplicate copy is sent to the department responsible for the deficiency and acts as a notice to that department that a charge for extra labor performed will be included in its departmental charges when the job is completed

Good production is then routed in the regular way. The production order accompanying the goods is marked to indicate goods "pulled out." Defective goods proceed under CDS through extra operations necessary until they reach the packing room and rejoin the original lot. Only those operations noted on CDS are charged as reoperation costs, regular operations are charged to the original manufacturing order.

Upon completion of extra operations, the CDS ticket is stamped complete, and goes to the accounting department. The latter computes the extra cost and sends the duplicate copy to the department responsible for spoilage.

**Procedure When Scrapping Spoiled Work**—When salvage through reworking is not possible, and goods must be scrapped, the procedure in the case illustrated above calls for making out a scrap ticket (Fig 12) as follows

The original copy accompanies the goods to the scrap department where the weight of the metals salvaged is noted on the ticket which is then sent to the cost department for cost pricing the goods through the last operation where the defect was noticed. The cost department also indicates the value of the metals salvaged. This ticket is then sent to the accounting department.

The duplicate copy is sent to the accounting department for make ready in the accounting set up and is then filed to await the receipt of the original copy from the cost department.

ORIGINAL									
<b>C D S</b> DEPT _____ DATE _____ NO _____ (CHANGES, DEFECTS, SHORTAGES)									
(ORDER SCHEDULED TO LEAVE DEPARTMENTS AS FOLLOWS)									
ORDER NO					ITEM NO		REC'D FROM		
ARTICLE									
REASON FOR ISSUING CDS							ISSUED BY		
							SCRAP TIC. NO		
DISPOSITION									
DEPT		OPERATION					S O NO.		TOTAL
CHARGE EXPENSE TO				APPROVED BY					
DEPT		S O NO		CHIEF INSPECTOR			DEPARTMENT CHARGED		
								PROD CLASS	

FIG 11 Report on Changes, Defects and Shortages

The triplicate copy is sent to the superintendent's office for the purpose of advising that department of the deficiency so that investigation may be made and steps taken to correct the cause.

The quadruplicate copy is sent to the department responsible for the defective goods to serve notice on it that charge will be forthcoming from the accounting department.

Additional labor may be necessary, even for scrap, such as disassembling goods before scrapping, separating by metals, etc. The CDS



ticket is made out for such costs and the scrap ticket number shown on the CDS ticket. The scrap department cost is charged to **general scrap expense**, and prorated to the departments responsible for scrap.

The cost department accumulates costs on the scrap ticket and sends the duplicate to the department responsible. Both CDS and scrap costs are carried to the departmental ledger accounts, from which at the end of month a summary is prepared.

The above procedure is similar to that reported by a manufacturer of brass products. A spoiled work scrapped form is made out in duplicate for all work to be scrapped other than legitimate scrap by the department scrapping the material. The duplicate is sent to the cost department, the original to the works manager's office for approval and returned to the originating department. This ticket then follows the lot of material to the scrap room where it is weighed and notation of weight made on the ticket, which is then sent to the cost department where the copies are matched and extended for costing purposes.

**RECLAMATION FORM**—A simplified method of handling waste and spoilage is shown in Fig 13 and is used, according to Hilbert by an instrument manufacturer (NACA Bulletin vol 18). The form issued in quadruplicate is a combination rejection and disposition slip for use in connection with raw material parts, subassemblies, and final assemblies. It may be used with a straight job order system, or standard costs. It is described as follows:

**Scrapped Material**—If the material is to be scrapped the first copy is destroyed and the second copy is retained at the reclamation office. The third and fourth copies are sent to the cost department. The cost department computes the value at the point of rejection and enters the detailed cost information on both copies in the spaces provided. The third copy is now filed under the lot number with the material requisition and time cards and is available as a credit when the final cost of the lot is calculated. The fourth copy is the basis of a journal entry which charges a factory expense and credits a direct product cost.

**Handling Material to be Reclaimed**—If the material is to be reclaimed, a reclamation order number is assigned and the sequence of departmental routing is entered in the department number column on the left side of the form by the reclamation office. This reclamation order number is a controlling system for guaranteeing the completion of the scheduled work. The first copy is sent to the production control department and is used as a follow up to prevent undue delays in final disposition. The second copy is retained in the reclamation department and is filed in part number sequence to show manufacturing hazards on various parts. The third copy is sent to the cost department where it is used as an authority for the acceptance of the charges to factory expenses that accrue from the remanufacturing. The fourth copy is routed through the various manufacturing departments and is authority for timekeepers to make charges directly to expense. After the operation is complete at which reclamation is scheduled to stop, the material is reunited to the lot on which it was originally rejected. The general policy is to defer closing of orders on which parts are rejected until reclamation work is completed. The fourth copy of the reclamation form is sent to the cost department where it is filed as a reference to be used when the lot cost is calculated.

**OBsolete MATERIAL SCRAPPED**—Some cost accountants classify obsolete material under the heading of spoilage. In a large num





ber of manufacturing companies obsolete material can bring about large losses unless some control is set up. An effective means of control is to have the sales department approve the scrapping of all obsolete parts and materials. A monthly or quarterly report should be prepared by the cost department and sent to the works manager, giving in detail the units, article value, and reasons for the necessary write off.

## SECTION 15

### TIMEKEEPING AND PAYROLLS

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## SECTION 15

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### TIMEKEEPING AND PAYROLLS

#### Definitions and Aims

**TIMEKEEPING DEFINED**—Timekeeping is defined as the detailed record of attendance or of time employed on a given assignment or the amount of work done. The purpose of timekeeping is to aid in the preparation of payrolls, labor distributions, and other labor cost records, also of records for burden application on a labor cost or labor hour basis. Recent developments have also emphasized another purpose of timekeeping which is the necessity of showing compliance with the various federal and state wage and hour laws. Companies are frequently called upon by governmental agencies to substantiate hours of work with the result that most employers have augmented their records considerably and have retained them on file for much longer periods of time in order to maintain an accurate record of employment hours. Many concerns have had to adopt payroll records for the purpose of indicating that attendance was in accordance with the law where no such records were ever deemed necessary in the past. This is particularly true in respect to office workers.

There are therefore three kinds of timekeeping

- 1 For purely attendance purposes including the evidence of compliance mentioned above
- 2 For payroll purposes
- 3 For labor and overhead costing

The first two are discussed in this section. The last is discussed in Section 16.

**PAYROLL ACCOUNTING DEFINED**—Payroll accounting is that branch of the accounting or cost accounting department's work concerned with the preparation of the periodic payrolls and their recording on the books of account. This involves the entire procedure connected with translating plant time or plant production into payroll dollars. It also includes procedures in connection with the many adjustments to an individual's pay made necessary under modern conditions.

**IMPORTANCE OF PAYROLL ACCOUNTING**—The importance of proper payroll procedure can be fully grasped only by a consideration of the various parties interested in the payroll. Primary interest in payroll accounting is of course centered in the worker who wants his pay and the employer who wants a record of what he received

for what he paid out. These represent internal relationships but there are also external parties whose interests are generally of the regulatory administrative type.

**Importance to External Parties**—To an increasing extent external parties have acquired a legal or moral interest in the payroll. These include

- 1 Federal and state governments' social security requirements in connection with
  - a Old age and survivors insurance deductions
  - b Unemployment insurance deductions
  - c Contributions by employer towards old age and unemployment insurance
  - d Individual earnings record
  - e In some states employers must report additions to and separations from the payroll, in connection with the administration of the laws of these states regarding partial seasonal and intermittent employment
- 2 Audits by governmental authorities. Even though an employer may consider himself exempt from social security regulations he must keep records
  - a To prove that he is exempt
  - b Because he cannot be entirely certain that he is exempt until near the end of the year
- 3 Information returns. Under this heading come statements of earnings filed with the Collector of Internal Revenue, covering payments made to workers.
- 4 Deductions at the source of personal state income taxes in some jurisdictions.
- 5 Collection of federal taxes at the source.
- 6 Requirements of the Fair Labor Standards Act of 1938 commonly called "The Wage and Hour Law." This establishes minimum ages of employees, maximum hours of work without extra compensation and minimum rates of pay to be observed under certain conditions. Payroll records of subject employers must be in such shape that compliance with this law can be verified by government inspectors.
- 7 Pay allotments. There is a growing tendency to allot pay for various purposes such as savings bank deposits, insurance premiums, investment securities, purchase of tools, payments for rent on company owned homes, union dues, etc. These are discussed in more detail later in this Section.

**Importance to Employee**—Modern industrialism recognizes that the relationship between employer and employee is more than a commercial transaction of buying time for cash. The pay envelope or pay check is a direct recurring point of contact between management and workers and affords management an opportunity for building up goodwill. While the worker is interested primarily in the size of his periodic earnings, the relationship between employer and employee may be strengthened by positive means, such as the establishment of insurance, thrift, pension plans and other pay allotment plans, also by negative means such as the avoidance of dissatisfaction due to pay disputes resulting from carelessly and inaccurately prepared payrolls, or the employment of unduly complex wage payment plans.

**Importance to Management**—Modern industrial operation requires a scientifically operated payroll system. In addition to paying the work

ness and satisfying all external interests, the individual employee is interested in labor cost accumulation and analyses for control purposes. Payroll departments must meet the problems of mass production incentive wage payment plans and the need for accurate costs. They must do so economically and promptly. However, as stated by Haskell and Robnett (N. A. C. A. Bulletin, vol. 21)

The two pressures of promptness and economy frequently work at cross purposes, particularly in situations where all workers are paid on the same day.

## Employment and Payroll Changes

**ORGANIZATION OF PERSONNEL AND PAYROLL FUNCTIONS**—The great volume of work connected with payroll administration involves four distinct functions:

- 1 Hiring, discharging, transferring of employees, and changes in rates of pay
- 2 Accumulation of time data
- 3 Preparation of the payroll
- 4 Disbursing of the payroll

Supplementary functions include the determination of labor costs (see Section 16) and the independent audit of all of the above through the office of the controller. The work of the four branches or functions must be so organized and related as to be in accord with sound principles of internal check. Local conditions dictate the exact organizational details so that standardization in this respect is not usually possible.

The first of the above-mentioned functions, that of employment, is performed by a separate **personnel department** in which all rates of pay, not only initially but at all times for increases and decreases, are agreed upon between employer and employee. These agreed rates are then passed to the payroll department and become the authority for that department in calculating payrolls. From the point of view of internal check, it is desirable that payroll additions for all new employees, deductions for released employees, and changes during the period of employment be authorized by the personnel department, at least in duplicate, and that one copy be retained in the personnel department, the other forwarded to the payroll department. Subsequently when the payroll is audited, a comparison of the data kept in the payroll and personnel departments provides a check against payments to fictitious persons or unauthorized changes in rates of pay.

The accumulation of time data is performed by the **timekeeping department**. The latter may be a separate department or it may be combined with the dispatching function. In the latter event the timekeeping function is undoubtedly under the direct supervision of the production control section rather than under the finance officer although the latter should exercise staff supervision through audits. Still another possibility is to combine the timekeeping function with the function of the payroll department proper. In any event timekeeping includes accounting for attendance as well as the assigning of time spent on individual tasks.

The time accounted for by the timekeeping department is eventually passed on to the payroll department which translates time into dollar amounts by the insertion of rates and the calculation of total and net pay after taking care of the many additions and deductions required under modern payroll accounting.

The disbursing of the payroll properly is handled by the paymaster and his staff. After the payroll has been checked the paymaster takes over the task of signing checks or stuffing envelopes and distributing them to the employees. The entire process is then summarized and passed on to the accounting department for recording in the books of account.

**Internal Check**—The logic of organization along the above lines is obvious. The payroll department prepares the payrolls within limits set by the personnel and timekeeping departments, while the paymaster controls the cash but disburses it only on the authority of the other departments. A multiple check is thus obtained for every dollar spent for payroll and the possibilities of manipulation through collusion are reduced to a minimum. Brink (Internal Auditing) briefly summarizes the features of internal check which merit special recognition in the case of payrolls:

- 1 The hiring of employees should be centralized in the hands of a personnel department and this department should keep independent records covering all persons employed by the company.
- 2 Care should be exercised that the initial record covering the labor service is prepared accurately and independently checked.
- 3 The underlying payroll data should be systematically controlled and linked to the maximum extent with production records.
- 4 The major parts of the payroll procedures—creation of the data, preparing the payroll, approval of the payroll, disbursement of the funds and cost analysis—should be in independent hands.
- 5 Payroll disbursements should be by check if possible.
- 6 Disbursements should be made directly to the employee by the disbursing officer in the presence of witnesses and a receipt obtained.
- 7 Special attention should be given to rate changes, employee deductions and unclaimed wages.

**CHANGE OF PAYROLL STATUS**—The prospective employee's first contact with a concern is through the personnel department. This department continues throughout the employee's tenure, to exercise a general supervisory function over the employee in all matters pertaining to personnel relations in which payroll matters occupy a prominent position.

The basis for the payroll is the payroll change recommendation (Fig 1) or the individual employment report (Fig 2). This presents an orderly method for recording and obtaining approvals for employment of new employees and separation of old ones, and for all changes in their payroll status during their periods of service. These forms and others related to them should be treated as confidential.

An individual payroll change recommendation (Fig 1) is originated for each pay period by a supervisory employee authorized to hire or discharge, or to initiate transfers or salary adjustments. He lists all changes in payroll status among the employees under his jurisdiction during the pay period and submits the form to the personnel depart-

PAY ROLL CHANGE				CHG OF NO	
				7051	
A TO P ALL		DAY PREPARED		DATE EFFECTIVE	
NO OCCUPA CH		October 24, 19--		October 24, 19--	
C M RATE		REASON			
HA E W K S HOURS		Revised Production Schedules			
OT CH ES					
DVT CH PAY O					
EMPL. NAME				EMPLOYEE'S NO	
Robinson, John E.				103	
OCCUPA TO	OLD			O FT OR LACE	
	NEW			DEPT O PLACE	
R TE	OLD R	PER	O TIME	OTHER COMPENSATION	
	N W S	P R	OVER TIME	OTHER COMPENSATION	
WORKING HOURS	OLD				
	NEW				
OTHER	OLD No 1 Shift				
	NEW No 2 Shift				
			JJ	" JJ	
			JLB	" JLB	

FIG 1 Payroll Change Recommendation

ment, or to the official designated to approve payroll matters. The principles of good internal check require that the employee who originates the payroll change recommendation should not be under direct domination by the approving official, the greatest possible independence of action between them is desirable.

**Payroll Change Recommendation**—The following changes in payroll status are taken care of by payroll change recommendations:

- 1 Additions to or removals from force
- 2 Transfers from one payroll unit, office or department to another
- 3 Changes in rate of pay
- 4 Leave of absence granted
- 5 Changes in title or occupational code
- 6 Changes in classification, e.g., from "temporary" to "regular" or from "part time" to "full time"
- 7 Changes in name, e.g., due to marriage or changes in spelling of name
- 8 Delayed assignment of social security account numbers

For convenience in routing payroll change recommendations are often prepared in two parts using separate pages, one part for miscellaneous changes not affecting rates of pay and the other part for changes in rates of pay or changes in personnel which affect the payroll totals. The latter normally require higher ranking approvals than the former.

**Information on Payroll Change Recommendation**—Payroll change recommendations convey the information listed as shown on Fig 1 to



EMPLOYMENT REPORT			
LOCATION		SERIAL NO	
THE FOLLOWING EMPLOYEE IS TO BE ADDED TO THE PAYROLL, EFFECTIVE (DATE) REMOVED FROM			
SOCIAL SECURITY NO.		CLOCK OR BADGE NO	
NAME			MALE FEMALE
ADDRESS			
EMPLOYED AS			
IN THE		DEPARTMENT	
RATE PER HOUR		RATE PER WEEK	
REMARKS			
APPROVED		RECOMMENDED	
DATE	TITLE	DATE	TITLE

FIG 2 Employment Report

the extent that is appropriate to the various types of changes listed above. One large company includes the following information on its payroll change form:

- 1 Location of plant and date of payroll period
- 2 Name of employee. The spelling must agree with the name shown on the employee's social security card or stub. Where a change of name is reported (e.g., due to marriage) both old and new names are shown.
- 3 Social security number. This is based upon the social security card or stub actually presented by each new employee. If the card is lost the employee is required to obtain a duplicate from the local social security office.
- 4 Occupational title. This is shown either spelled out or in code.
- 5 Basic rate of pay. Where a change of rate is recommended both old and new rates are shown.
- 6 Date. The day that the change is to be effective which may not necessarily be the beginning or end of the payroll period.
- 7 Net amount of change. The amount of change per pay period is entered to facilitate executive scrutiny and to aid in balancing the control totals.
- 8 Explanation. Each item is clearly explained by notations such as "Engaged," "Increase in Rate," "Transferred to," etc. The term "Engaged" is supplemented by the explanation "Reinstatement" or "New Employee," if known. Particular care must be taken to explain accurately the reasons for separations from the payroll because state unemployment insurance benefits are dependent upon this information. Such reasons as "Discharged for Cause" or "Voluntary Resignation" may result in an extended waiting period or other penalty before benefits can be obtained whereas "Laid Off No Work" usually entitles the employee to preferred status with respect to unemployment benefits.
- 9 Signatures of recommending and approving officials. If there are several pages each page is separately signed and approved to lessen the chance of subsequent substitution or alteration of the sheets.

In the same company all changes in payroll status are listed on one form which therefore serves as a **summary of payroll changes** in each department. Where individual forms are used, such as Fig 1, they must be summarized on a separate form (Fig 3). A by-product of this summary is the ability to obtain **payroll control totals**. These are obtained from the previous period's control total after tracing the effects of the changes taking place in each period. The amount of change is obtained by multiplying for each employee the normal hours by the hourly rates. The net change is added to or subtracted from the previous control total of the payroll to establish the control figure for the current roll.

**General Payroll Change**—In the event of a general uniform change in wage scale, a single blanket entry may be made showing the number of employees, the rate of change and the total amounts involved. This can be supported by the detailed **addressing machine proof sheets** described on page 806 showing old and new rates for each employee, thereby saving much detail work.

**INDIVIDUAL EMPLOYMENT REPORT**—Payroll change recommendations should be compiled, approved, and forwarded to reach the payroll department in time for use in preparing the current payroll.

Where more prompt reporting of additions and separations is required than is provided by a periodical payroll change recommendation report an individual employment report, or "hire slip" for each employee (Fig 2) is found more satisfactory. The internal check provided by the

SUMMARY OF PAYROLL CHANGES			
LOCATION		WEEK ENDING	
PREVIOUS PAYROLL CONTROL TOTAL			\$
CHANGES PER INDIVIDUAL EMPLOYMENT			
REPORTS NOS	TO	INCLUSIVE	
ADDITIONS		\$	
SEPARATIONS			
NET CHANGE			\$
CHANGES PER BLANKET PAYROLL CHANGE RECOMMENDATION FOR CURRENT PERIOD			
TOTAL, NEW RATES		\$	
TOTAL, OLD RATES			
NET CHANGE			\$
NEW PAYROLL CONTROL TOTAL			\$
REMARKS			
APPROVED		SIGNED	
DATE TITLE		DATE TITLE	

Fig 3 Summary of Payroll Changes

progressive payroll control totals on the periodical report is absent on the individual employment report. A measure of control over the latter may be established by using prenumbered forms. The paymaster or auditor can then check the continuity of serial numbers and prepare a reconciliation of payroll totals or summary of payroll changes each pay period.

**TOOL ISSUANCE RECORD**—Fig 4 constitutes a record of tools, keys, etc., issued to a new employee, it may be a separate form, or may be printed on the reverse side of a copy of the employment report. The payroll and plant tool departments maintain controls to insure that tools, badges, identification cards, etc., are turned in by departing employees upon termination of their employment. The tool issuance record thus becomes in effect an employee release card. The release serves as notice for a change of record and the basis, if desired.

EMPLOYEE'S NAME				DEPT	
LOCKER KEY NO			IDENTIFICATION BADGE NO		
DATE		SIZE	DESCRIPTION OF TOOL	REQ'D NUMBER	REMARKS
ISSUED	RET'D				
Empl Mgr	Dept Fore	Supt	Head TK		
ALL OF THE FOREGOING HAVE BEEN RETURNED IN GOOD ORDER EXCEPT AS NOTED UNDER "REMARKS"					
SIGNED				STOREKEEPER	

Fig 4 Tool Issuance Record

for investigation into the reasons for leaving. Note the spaces for initials of the employment manager, departmental foreman, superintendent, head timekeeper, etc., also details as to return of locker keys and tools. In some plants, upon leaving the service, an employee receives his final pay through the medium of an order on the paymaster for final payment of wages (Fig 5). This combines the tool record and employee's release with the final pay order. Note detail of deductions as well as signature of department heads checking and passing on their part of the release of an employee. Toolroom, health department, pay-

FORM 475-324-33-35		PAID IN FULL TICKET		ORIGINAL TO PAYMASTER	
PAYMASTER:		DATE _____			
PAY _____		CLOCK NO _____		DEPT NO. _____	
LAST DAY TO BE PAID (DATE) _____		HOURS _____		MIN _____	
SIGNATURE OF FOREMAN _____					
DEDUCT FROM PAY OF ABOVE EMPLOYEE AS NOTED BELOW					
	LOCK AND KEY _____	DOLLA	CENTS	TWO FROM SIX TO E	
	TOOL _____			NEX CLEARING (N R E)	
	TOOL _____			P RTR S GRATE	
	TOOL _____			E PAYMENT SUFF S SH TURE	
	BADGE _____				
	TOTAL _____			HAS BADGE _____ NO BADGE _____	

FIG 5 Order for Final Payment of Wages

master, and employment department, are all interested in this particular point in the release of each employee

**NAME STENCILS**—From the payroll change recommendation or the employment report, the payroll department prepares addressing machine stencils, heads up time clock cards and individual earnings records prepares badges or identification cards, etc. The stencils are kept locked up or otherwise safeguarded in order to keep rates of pay confidential and to prevent unauthorized persons from preparing clock cards or other payroll documents which might be misused.

If there is a separate timekeeping department, not a part of the payroll department, a copy of the payroll change recommendation is sent to the timekeeper as the basis for establishing time records pending receipt of routine time cards from the addressing machine section.

**EMPLOYEE'S SERVICE RECORD**—In most concerns it is desirable to maintain a permanent record of the service history of each employee. Fig. 6 shows a very complete record giving complete information concerning the employee, both at the start of employment and throughout his association with the concern.

The following information required under the Fair Labor Standards Act of 1938 can conveniently be recorded on the employee's service record: name in full and any clock number or other code or abbreviation used to identify the employee, home address, date of birth, occupation and basis on which wages are paid, e.g., "50¢ per hr." "\$3.00 a day" "piece rates," etc. If all employees do not have the same work week, the time of day and the name of the day on which each employ-



SERVICE RECORD									
1. ABOVE AVERAGE 2. AVERAGE 3. BELOW AVERAGE									
4. EMPLOY 5. CHARTER 6. DEFECT 7. DEFEND 8. QUANTITY 9. QUALITY									
10	11	12	13	14	15	16	17	18	19
NAME _____ PRESENT ADDRESS _____ TELEPHONE NO. _____ HOME ADDRESS _____ IN CASE OF EMERGENCY NOTIFY _____									
SOCIAL SECURITY NO. _____ 1. MA. 2. ILL. 3. CALIF. 4. TEX. 5. N.Y. 6. PA. 7. OH. 8. IND. 9. WIS. 10. MICH. 11. MINN. 12. IOWA 13. MO. 14. ARK. 15. LA. 16. MISS. 17. ALA. 18. GA. 19. FLA. 20. SC. 21. N.C. 22. S.C. 23. VA. 24. W. VA. 25. KY. 26. TENN. 27. MISS. 28. ALA. 29. GA. 30. FLA. 31. SC. 32. N.C. 33. S.C. 34. VA. 35. W. VA. 36. KY. 37. TENN. 38. MISS. 39. ALA. 40. GA. 41. FLA. 42. SC. 43. N.C. 44. S.C. 45. VA. 46. W. VA. 47. KY. 48. TENN. 49. MISS. 50. ALA. 51. GA. 52. FLA. 53. SC. 54. N.C. 55. S.C. 56. VA. 57. W. VA. 58. KY. 59. TENN. 60. MISS. 61. ALA. 62. GA. 63. FLA. 64. SC. 65. N.C. 66. S.C. 67. VA. 68. W. VA. 69. KY. 70. TENN. 71. MISS. 72. ALA. 73. GA. 74. FLA. 75. SC. 76. N.C. 77. S.C. 78. VA. 79. W. VA. 80. KY. 81. TENN. 82. MISS. 83. ALA. 84. GA. 85. FLA. 86. SC. 87. N.C. 88. S.C. 89. VA. 90. W. VA. 91. KY. 92. TENN. 93. MISS. 94. ALA. 95. GA. 96. FLA. 97. SC. 98. N.C. 99. S.C. 100. VA. 101. W. VA. 102. KY. 103. TENN. 104. MISS. 105. ALA. 106. GA. 107. FLA. 108. SC. 109. N.C. 110. S.C. 111. VA. 112. W. VA. 113. KY. 114. TENN. 115. MISS. 116. ALA. 117. GA. 118. FLA. 119. SC. 120. N.C. 121. S.C. 122. VA. 123. W. VA. 124. KY. 125. TENN. 126. MISS. 127. ALA. 128. GA. 129. FLA. 130. SC. 131. N.C. 132. S.C. 133. VA. 134. W. VA. 135. KY. 136. TENN. 137. MISS. 138. ALA. 139. GA. 140. FLA. 141. SC. 142. N.C. 143. S.C. 144. VA. 145. W. VA. 146. KY. 147. TENN. 148. MISS. 149. ALA. 150. GA. 151. FLA. 152. SC. 153. N.C. 154. S.C. 155. VA. 156. W. VA. 157. KY. 158. TENN. 159. MISS. 160. ALA. 161. GA. 162. FLA. 163. SC. 164. N.C. 165. S.C. 166. VA. 167. W. VA. 168. KY. 169. TENN. 170. MISS. 171. ALA. 172. GA. 173. FLA. 174. SC. 175. N.C. 176. S.C. 177. VA. 178. W. VA. 179. KY. 180. TENN. 181. MISS. 182. ALA. 183. GA. 184. FLA. 185. SC. 186. N.C. 187. S.C. 188. VA. 189. W. VA. 190. KY. 191. TENN. 192. MISS. 193. ALA. 194. GA. 195. FLA. 196. SC. 197. N.C. 198. S.C. 199. VA. 200. W. VA. 201. KY. 202. TENN. 203. MISS. 204. ALA. 205. GA. 206. FLA. 207. SC. 208. N.C. 209. S.C. 210. VA. 211. W. VA. 212. KY. 213. TENN. 214. MISS. 215. ALA. 216. GA. 217. FLA. 218. SC. 219. N.C. 220. S.C. 221. VA. 222. W. VA. 223. KY. 224. TENN. 225. MISS. 226. ALA. 227. GA. 228. FLA. 229. SC. 230. N.C. 231. S.C. 232. VA. 233. W. VA. 234. KY. 235. TENN. 236. MISS. 237. ALA. 238. GA. 239. FLA. 240. SC. 241. N.C. 242. S.C. 243. VA. 244. W. VA. 245. KY. 246. TENN. 247. MISS. 248. ALA. 249. GA. 250. FLA. 251. SC. 252. N.C. 253. S.C. 254. VA. 255. W. VA. 256. KY. 257. TENN. 258. MISS. 259. ALA. 260. GA. 261. FLA. 262. SC. 263. N.C. 264. S.C. 265. VA. 266. W. VA. 267. KY. 268. TENN. 269. MISS. 270. ALA. 271. GA. 272. FLA. 273. SC. 274. N.C. 275. S.C. 276. VA. 277. W. VA. 278. KY. 279. TENN. 280. MISS. 281. ALA. 282. GA. 283. FLA. 284. SC. 285. N.C. 286. S.C. 287. VA. 288. W. VA. 289. KY. 290. TENN. 291. MISS. 292. ALA. 293. GA. 294. FLA. 295. SC. 296. N.C. 297. S.C. 298. VA. 299. W. VA. 300. KY. 301. TENN. 302. MISS. 303. ALA. 304. GA. 305. FLA. 306. SC. 307. N.C. 308. S.C. 309. VA. 310. W. VA. 311. KY. 312. TENN. 313. MISS. 314. ALA. 315. GA. 316. FLA. 317. SC. 318. N.C. 319. S.C. 320. VA. 321. W. VA. 322. KY. 323. TENN. 324. MISS. 325. ALA. 326. GA. 327. FLA. 328. SC. 329. N.C. 330. S.C. 331. VA. 332. W. VA. 333. KY. 334. TENN. 335. MISS. 336. ALA. 337. GA. 338. FLA. 339. SC. 340. N.C. 341. S.C. 342. VA. 343. W. VA. 344. KY. 345. TENN. 346. MISS. 347. ALA. 348. GA. 349. FLA. 350. SC. 351. N.C. 352. S.C. 353. VA. 354. W. VA. 355. KY. 356. TENN. 357. MISS. 358. ALA. 359. GA. 360. FLA. 361. SC. 362. N.C. 363. S.C. 364. VA. 365. W. VA. 366. KY. 367. TENN. 368. MISS. 369. ALA. 370. GA. 371. FLA. 372. SC. 373. N.C. 374. S.C. 375. VA. 376. W. VA. 377. KY. 378. TENN. 379. MISS. 380. ALA. 381. GA. 382. FLA. 383. SC. 384. N.C. 385. S.C. 386. VA. 387. W. VA. 388. KY. 389. TENN. 390. MISS. 391. ALA. 392. GA. 393. FLA. 394. SC. 395. N.C. 396. S.C. 397. VA. 398. W. VA. 399. KY. 400. TENN. 401. MISS. 402. ALA. 403. GA. 404. FLA. 405. SC. 406. N.C. 407. S.C. 408. 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W. VA. 509. KY. 510. TENN. 511. MISS. 512. ALA. 513. GA. 514. FLA. 515. SC. 516. N.C. 517. S.C. 518. VA. 519. W. VA. 520. KY. 521. TENN. 522. MISS. 523. ALA. 524. GA. 525. FLA. 526. SC. 527. N.C. 528. S.C. 529. VA. 530. W. VA. 531. KY. 532. TENN. 533. MISS. 534. ALA. 535. GA. 536. FLA. 537. SC. 538. N.C. 539. S.C. 540. VA. 541. W. VA. 542. KY. 543. TENN. 544. MISS. 545. ALA. 546. GA. 547. FLA. 548. SC. 549. N.C. 550. S.C. 551. VA. 552. W. VA. 553. KY. 554. TENN. 555. MISS. 556. ALA. 557. GA. 558. FLA. 559. SC. 560. N.C. 561. S.C. 562. VA. 563. W. VA. 564. KY. 565. TENN. 566. MISS. 567. ALA. 568. GA. 569. FLA. 570. SC. 571. N.C. 572. S.C. 573. VA. 574. W. VA. 575. KY. 576. TENN. 577. MISS. 578. ALA. 579. GA. 580. FLA. 581. SC. 582. N.C. 583. S.C. 584. VA. 585. W. VA. 586. KY. 587. TENN. 588. MISS. 589. ALA. 590. GA. 591. FLA. 592. SC. 593. N.C. 594. S.C. 595. VA. 596. W. VA. 597. KY. 598. TENN. 599. MISS. 600. ALA. 601. GA. 602. FLA. 603. SC. 604. N.C. 605. S.C. 606. VA. 607. W. VA. 608. KY. 609. TENN. 610. MISS. 611. ALA. 612. GA. 613. FLA. 614. SC. 615. N.C. 616. S.C. 617. VA. 618. W. VA. 619. KY. 620. TENN. 621. MISS. 622. ALA. 623. GA. 624. FLA. 625. SC. 626. N.C. 627. S.C. 628. VA. 629. W. VA. 630. KY. 631. TENN. 632. MISS. 633. ALA. 634. GA. 635. FLA. 636. SC. 637. N.C. 638. S.C. 639. VA. 640. W. VA. 641. KY. 642. TENN. 643. MISS. 644. ALA. 645. GA. 646. FLA. 647. SC. 648. N.C. 649. S.C. 650. VA. 651. W. VA. 652. KY. 653. TENN. 654. MISS. 655. ALA. 656. GA. 657. FLA. 658. SC. 659. N.C. 660. S.C. 661. VA. 662. W. VA. 663. KY. 664. TENN. 665. MISS. 666. ALA. 667. GA. 668. FLA. 669. SC. 670. N.C. 671. S.C. 672. VA. 673. W. VA. 674. KY. 675. TENN. 676. MISS. 677. ALA. 678. GA. 679. FLA. 680. SC. 681. N.C. 682. S.C. 683. VA. 684. W. VA. 685. KY. 686. TENN. 687. MISS. 688. ALA. 689. GA. 690. FLA. 691. SC. 692. N.C. 693. S.C. 694. VA. 695. W. VA. 696. KY. 697. TENN. 698. MISS. 699. ALA. 700. GA. 701. FLA. 702. SC. 703. N.C. 704. S.C. 705. VA. 706. W. VA. 707. KY. 708. TENN. 709. MISS. 710. ALA. 711. GA. 712. FLA. 713. SC. 714. N.C. 715. S.C. 716. VA. 717. W. VA. 718. KY. 719. TENN. 720. MISS. 721. ALA. 722. GA. 723. FLA. 724. SC. 725. N.C. 726. S.C. 727. VA. 728. W. VA. 729. KY. 730. TENN. 731. MISS. 732. ALA. 733. GA. 734. FLA. 735. SC. 736. N.C. 737. S.C. 738. VA. 739. W. VA. 740. KY. 741. TENN. 742. MISS. 743. ALA. 744. GA. 745. FLA. 746. SC. 747. N.C. 748. S.C. 749. VA. 750. W. VA. 751. KY. 752. TENN. 753. MISS. 754. ALA. 755. GA. 756. FLA. 757. SC. 758. N.C. 759. S.C. 760. VA. 761. W. VA. 762. KY. 763. TENN. 764. MISS. 765. ALA. 766. GA. 767. FLA. 768. SC. 769. N.C. 770. S.C. 771. VA. 772. W. VA. 773. KY. 774. TENN. 775. MISS. 776. ALA. 777. GA. 778. FLA. 779. SC. 780. N.C. 781. S.C. 782. VA. 783. W. VA. 784. KY. 785. TENN. 786. MISS. 787. ALA. 788. GA. 789. FLA. 790. SC. 791. N.C. 792. S.C. 793. VA. 794. W. VA. 795. KY. 796. TENN. 797. MISS. 798. ALA. 799. GA. 800. FLA. 801. SC. 802. N.C. 803. S.C. 804. VA. 805. W. VA. 806. KY. 807. TENN. 808. MISS. 809. ALA. 810. GA. 811. FLA. 812. SC. 813. N.C. 814. S.C. 815. VA. 816. W. VA. 817. KY. 818. TENN. 819. MISS. 820. ALA. 821. GA. 822. FLA. 823. SC. 824. N.C. 825. S.C. 826. VA. 827. W. VA. 828. KY. 829. TENN. 830. MISS. 831. ALA. 832. GA. 833. FLA. 834. SC. 835. N.C. 836. S.C. 837. VA. 838. W. VA. 839. KY. 840. TENN. 841. MISS. 842. ALA. 843. GA. 844. FLA. 845. SC. 846. N.C. 847. S.C. 848. VA. 849. W. VA. 850. KY. 851. TENN. 852. MISS. 853. ALA. 854. GA. 855. FLA. 856. SC. 857. N.C. 858. S.C. 859. VA. 860. W. VA. 861. KY. 862. TENN. 863. MISS. 864. ALA. 865. GA. 866. FLA. 867. SC. 868. N.C. 869. S.C. 870. VA. 871. W. VA. 872. KY. 873. TENN. 874. MISS. 875. ALA. 876. GA. 877. FLA. 878. SC. 879. N.C. 880. S.C. 881. VA. 882. W. VA. 883. KY. 884. TENN. 885. MISS. 886. ALA. 887. GA. 888. FLA. 889. SC. 890. N.C. 891. S.C. 892. VA. 893. W. VA. 894. KY. 895. TENN. 896. MISS. 897. ALA. 898. GA. 899. FLA. 900. SC. 901. N.C. 902. S.C. 903. VA. 904. W. VA. 905. KY. 906. TENN. 907. MISS. 908. ALA. 909. GA. 910. FLA. 911. SC. 912. N.C. 913. S.C. 914. VA. 915. W. VA. 916. KY. 917. TENN. 918. MISS. 919. ALA. 920. GA. 921. FLA. 922. SC. 923. N.C. 924. S.C. 925. VA. 926. W. VA. 927. KY. 928. TENN. 929. MISS. 930. ALA. 931. GA. 932. FLA. 933. SC. 934. N.C. 935. S.C. 936. VA. 937. W. VA. 938. KY. 939. TENN. 940. MISS. 941. ALA. 942. GA. 943. FLA. 944. SC. 945. N.C. 946. S.C. 947. VA. 948. W. VA. 949. KY. 950. TENN. 951. MISS. 952. ALA. 953. GA. 954. FLA. 955. SC. 956. N.C. 957. S.C. 958. VA. 959. W. VA. 960. KY. 961. TENN. 962. MISS. 963. ALA. 964. GA. 965. FLA. 966. SC. 967. N.C. 968. S.C. 969. VA. 970. W. VA. 971. KY. 972. TENN. 973. MISS. 974. ALA. 975. GA. 976. FLA. 977. SC. 978. N.C. 979. S.C. 980. VA. 981. W. VA. 982. KY. 983. TENN. 984. MISS. 985. ALA. 986. GA. 987. FLA. 988. SC. 989. N.C. 990. S.C. 991. VA. 992. W. VA. 993. KY. 994. TENN. 995. MISS. 996. ALA. 997. GA. 998. FLA. 999. SC. 1000. N.C. 1001. S.C. 1002. VA. 1003. W. VA. 1004. KY. 1005. TENN. 1006. MISS. 1007. ALA. 1008. GA. 1009. FLA. 1010. SC. 1011. N.C. 1012. S.C. 1013. VA. 1014. W. VA. 1015. KY. 1016. TENN. 1017. MISS. 1018. ALA. 1019. GA. 1020. FLA. 1021. SC. 1022. N.C. 1023. S.C. 1024. VA. 1025. W. VA. 1026. KY. 1027. TENN. 1028. MISS. 1029. ALA. 1030. GA. 1031. FLA. 1032. SC. 1033. N.C. 1034. S.C. 1035. VA. 1036. W. VA. 1037. KY. 1038. TENN. 1039. MISS. 1040. ALA. 1041. GA. 1042. FLA. 1043. SC. 1044. N.C. 1045. S.C. 1046. VA. 1047. W. VA. 1048. KY. 1049. TENN. 1050. MISS. 1051. ALA. 1052. GA. 1053. FLA. 1054. SC. 1055. N.C. 1056. S.C. 1057. VA. 1058. W. VA. 1059. KY. 1060. TENN. 1061. MISS. 1062. ALA. 1063. GA. 1064. FLA. 1065. SC. 1066. N.C. 1067. S.C. 1068. VA. 1069. W. VA. 1070. KY. 1071. TENN. 1072. MISS. 1073. ALA. 1074. GA. 1075. FLA. 1076. SC. 1077. N.C. 1078. S.C. 1079. VA. 1080. W. VA. 1081. KY. 1082. TENN. 1083. MISS. 1084. ALA. 1085. GA. 1086. FLA. 1087. SC. 1088. N.C. 1089. S.C. 1090. VA. 1091. W. VA. 1092. KY. 1093. TENN. 1094. MISS. 1095. ALA. 1096. GA. 1097. FLA. 1098. SC. 1099. N.C. 1100. S.C. 1101. VA. 1102. W. VA. 1103. KY. 1104. TENN. 1105. MISS. 1106. ALA. 1107. GA. 1108. FLA. 1109. SC. 1110. N.C. 1111. S.C. 1112. VA. 1113. W. VA. 1114. KY. 1115. TENN. 1116. MISS. 1117. ALA. 1118. GA. 1119. FLA. 1120. SC. 1121. N.C. 1122. S.C. 1123. VA. 1124. W. VA. 1125. KY. 1126. TENN. 1127. MISS. 1128. ALA. 1129. GA. 1130. FLA. 1131. SC. 1132. N.C. 1133. S.C. 1134. VA. 1135. W. VA. 1136. KY. 1137. TENN. 1138. MISS. 1139. ALA. 1140. GA. 1141. FLA. 1142. SC. 1143. N.C. 1144. S.C. 1145. VA. 1146. W. VA. 1147. KY. 1148. TENN. 1149. MISS. 1150. ALA. 1151. GA. 1152. FLA. 1153. SC. 1154. N.C. 1155. S.C. 1156. VA. 1157. W. VA. 1158. KY. 1159. TENN. 1160. MISS. 1161. ALA. 1162. GA. 1163. FLA. 1164. SC. 1165. N.C. 1166. S.C. 1167. VA. 1168. W. VA. 1169. KY. 1170. TENN. 1171. MISS. 1172. ALA. 1173. GA. 1174. FLA. 1175. SC. 1176. N.C. 1177. S.C. 1178. VA. 1179. W. VA. 1180. KY. 1181. TENN. 1182. MISS. 1183. ALA. 1184. GA. 1185. FLA. 1186. SC. 1187. N.C. 1188. S.C. 1189. VA. 1190. W. VA. 1191. KY. 1192. TENN. 1193. MISS. 1194. ALA. 1195. GA. 1196. FLA. 1197. SC. 1198. N.C. 1199. S.C. 1200. VA. 1201. W. VA. 1202. KY. 1203. TENN. 1204. MISS. 1205. ALA. 1206. GA. 1207. FLA. 1208. SC. 1209. N.C. 1210. S.C. 1211. VA. 1212. W. VA. 1213. KY. 1214. TENN. 1215. MISS. 1216. ALA. 1217. GA. 1218. FLA. 1219. SC. 1220. N.C. 1221. S.C. 1222. VA. 1223. W. VA. 1224. KY. 1225. TENN. 1226. MISS. 1227. ALA. 1228. GA. 1229. FLA. 1230. SC. 1231. N.C. 1232. S.C. 1233. VA. 1234. W. VA. 1235. KY. 1236. TENN. 1237. MISS. 1238. ALA. 1239. GA. 1240. FLA. 1241. SC. 1242. N.C. 1243. S.C. 1244. VA. 1245. W. VA. 1246. KY. 1247. TENN. 1248. MISS. 1249. ALA. 1250. GA. 1251. FLA. 1252. SC. 1253. N.C. 1254. S.C. 1255. VA. 1256. W. VA. 1257. KY. 1258. TENN. 1259. MISS. 1260. ALA. 1261. GA. 1262. FLA. 1263. SC. 1264. N.C. 1265. S.C. 1266. VA. 1267. W. VA. 1268. KY. 1269. TENN. 1270. MISS. 1271. ALA. 1272. GA. 1273. FLA. 1274. SC. 1275. N.C. 1276. S.C. 1277. VA. 1278. W. VA. 1279. KY. 1280. TENN. 1281. MISS. 1282. ALA. 1283. GA. 1284. FLA. 1285. SC. 1286. N.C. 1287. S.C. 1288. VA. 1289. W. VA. 1290. KY. 1291. TENN. 1292. MISS. 1293. ALA. 1294. GA. 1295. FLA. 1296. SC. 1297. N.C. 1298. S.C. 1299. VA. 1300. W. VA. 1301. KY. 1302. TENN. 1303. MISS. 1304. ALA. 1305. GA. 1306. FLA. 1307. SC. 1308. N.C. 1309. S.C. 1310. VA. 1311. W. VA. 1312. KY. 1313. TENN. 1314. MISS. 1315. ALA. 1316. GA. 1317. FLA. 1318. SC. 1319. N.C. 1320. S.C. 1321. VA. 1322. W. VA. 1323. KY. 1324. TENN. 1325. MISS. 1326. ALA. 1327. GA. 1328. FLA. 1329. SC. 1330. N.C. 1331. S.C. 1332. VA. 1333. W. VA. 1334. KY. 1335. TENN. 1336. MISS. 1337. ALA. 1338. GA. 1339. FLA. 1340. SC. 1341. N.C. 1342. S.C. 1343. VA. 1344. W. VA. 1345. KY. 1346. TENN. 1347. MISS. 1348. ALA. 1349. GA. 1350. FLA. 1351. SC. 1352. N.C. 1353. S.C. 1354. VA. 1355. W. VA. 1356. KY. 1357. TENN. 1358. MISS. 1359. ALA. 1360. GA. 1361. FLA. 1362. SC. 1363. N.C. 1364. S.C. 1365. VA. 1366. W. VA. 1367. KY. 1368. TENN. 1369. MISS. 1370. ALA. 1371. GA. 1372. FLA. 1373. SC. 1374. N.C. 1375. S.C. 1376. VA. 1377. W. VA. 1378. KY. 1379. TENN. 1380. MISS. 1381. ALA. 1382. GA. 1383. FLA. 1384. SC. 1385. N.C. 1386. S.C. 1387. VA. 1388. W. VA. 1389. KY. 1390. TENN. 1391. MISS. 1392. ALA. 1393. GA. 1394. FLA. 1395. SC. 1396. N.C. 1397. S.C. 1398. VA. 1399. W. VA. 1400. KY. 1401. TENN. 1402. MISS. 1403. ALA. 1404. GA. 1405. FLA. 1406. SC. 1407. N.C. 1408. S.C. 1409. VA. 1410. W. VA. 1411. KY. 1412. TENN. 1413. MISS. 1414. ALA. 1415. GA. 1416. FLA. 1417. SC. 1418. N.C. 1419. S.C. 1420. VA. 1421. W. VA. 1422. KY. 1423. TENN. 1424. MISS. 1425. ALA. 1426. GA. 1427. FLA. 1428. SC. 1429. N.C. 1430. S.C. 1431. VA. 1432. W. VA. 1433. KY. 1434. TENN. 1435. MISS. 1436. ALA. 1437. GA. 1438. FLA. 1439. SC. 1440. N.C. 1441. S.C. 1442. VA. 1443. W. VA. 1444. KY. 1445. TENN. 1446. MISS. 1447. ALA. 1448. GA. 1449. FLA. 1450. SC. 1451. N.C. 1452. S.C. 1453. VA. 1454. W. VA. 1455. KY. 1456. TENN. 1457. 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ee's work week begins can best be recorded on his service record. Other required information may be shown on attendance time record, payroll, or individual earnings record etc. Home addresses should be checked and corrected with reasonable frequency to meet Fair Labor Standards Act requirements. If the employee's age is under 19, it is necessary

- 1 To consult the law and make notations on the employee's service record showing why it is believed that the child labor provisions of the law are not violated.
- 2 To attach a certificate of age issued in accordance with regulations of the Children's Bureau showing that the child is above the legal age for employment in the occupation in which he is engaged.

A record of the type of occupation on the employee's service record is important wherever it may form the basis on which a partial or complete exemption is claimed from limitations provided in the Fair Labor Standards Act.

The form may also include any agreement with the company, after the initial rate is inserted, it is signed by the employee. New employees should be carefully advised as to when they will receive their first pay where to get it, and what formalities or identification are necessary. They should also be told about any payroll deduction plans in effect, and should have an opportunity at once to sign any deduction authorizations which may be in order for new employees. These are attached to the new employee's service record form. The form is attached to the related payroll change recommendation or employment report and sent to the payroll department where the two together are used as the basis for setting up addressing machine stencils, tabulating master cards, or other means of inserting the names on the payroll.

**Posting to Employee's Service Record**—Subsequent entries in the lower portion of the form, and continuing to similar columns on the reverse side, are posted by the payroll department from subsequent payroll change recommendations or employment reports. Current record forms are kept in a suitably arranged file in the payroll department. Record forms of ex-employees are held in a transfer file permanently or until the employee is reengaged and his record returned to the active file.

In certain industries particular care must be exercised in selecting and identifying employees. In such special cases a fingerprint record is appropriate. Instructions for the use of this form may be obtained from the Federal Bureau of Investigation.

## Timekeeping for Payroll Purposes

**PURPOSE OF TIMEKEEPING**—There are two phases of timekeeping: the attendance record for payroll purposes, and the job record or work report for cost classification purposes. The two may be combined into a single record, or they may be separate records which are reconciled with each other upon completion, or they may be entirely independent records without reconciliation. The latter procedure usually results in considerable confusion. Generally speaking, the maintenance of two independent sets of records for the accumulation of similar data is undesirable.



The fundamental purposes of the attendance record are

- 1 To disclose absence or tardiness for which deductions from pay may be made
- 2 To measure overtime for which extra pay may be due
- 3 To provide a record as evidence of compliance with the Fair Labor Standards Act of 1938

**ATTENDANCE REQUIREMENTS UNDER WAGE AND HOUR LAW**—As a protection against legal entanglements, there should be definite written instructions fixing the regular hours of work and forbidding employees to occupy the premises outside of those working hours without authority. However, mere publication of such rules is not legally sufficient. They must be enforced, and as positive evidence of compliance an attendance register or time clock record should be provided.

Note that posting a notice specifying regular hours of work and forbidding overtime does not release an employer from the obligation to keep a record of hours actually worked. This is important in connection with clerical or other overhead employees. Note also that job records of actual working time are not sufficient. Waiting time constitutes time worked and must be recorded as such, whenever an employee is required to be on duty on the employer's premises, or at a prescribed workplace, or when the time is too short for the employee to spend it for his own purposes. Several work weeks may be included in the pay period but overtime is determined on the basis of each separate work week. The time records must show all this information clearly.

**ATTENDANCE REGISTERS**—For the purpose outlined above, an old-fashioned manual register may be used. Each employee signs the register upon arrival or departure and notes time in or time out. The entries should of course, progress in sequence. This form of record is, however, subject to abuse by employees. An outgrowth of the old manual register is a time register device in which the employee puts his signature and time of arrival or departure on the exposed portion of a tape, then pulls a lever which moves the written portion of the tape out of sight into an enclosed housing. The next employee then cannot know the time entered by his predecessor and therefore must record his own time honestly. A variation of this device is the autographic time register (Fig. 7) in which the pulling of the lever automatically stamps the time opposite the employee's signature.

The chief drawback of the manual register and also of the autographic register is the necessity for posting the entries to individual attendance records in order to meet fully the fundamental purposes of the procedure.

**TIME CLOCK**—The above objections are overcome by the time clock. Most time clocks comprise two basic features:

- 1 A clock driven printing mechanism which stamps the exact time
- 2 An individual time card for each employee (Fig. 8) upon which the times "In" and "Out" are stamped for each working period.

In some models a tape record is also provided, locked within the mechanism which shows the employees' clock numbers and time "In" or "Out" in chronological order. Usually the in-and-out card provides

1223	JB Kettleton	✓
1225	Geo Haydock	✓
1228	BB Hill	✓
1231	W R Hensley	✓
1232	Car Anderson	✓
1231	Al Perry	✓
1230	FC Kutz	✓
1230	Earl Carston	✓
1230	Russell Jones	✓
1230	Joe Menden	✓
1231	Geo Haydock	-
1230	BB Hill	-

FIG 7 Autographic Attendance Record

52																																																																							
NO	A W Kirkman																																																																						
NAME																																																																							
Days W & d	5, 10/28																																																																						
IN	40, 85, 34.00																																																																						
OUT	3, 128, 384																																																																						
Total	37.84																																																																						
Start	8:00																																																																						
End	3:30																																																																						
Total	5:38																																																																						
Other	Adv 19/10 \$5.00																																																																						
Balance	32.46																																																																						
<table border="1"> <thead> <tr> <th rowspan="2">Days</th> <th colspan="2">MORNING</th> <th colspan="2">AFTERNOON</th> <th colspan="2">OVERTIME</th> <th rowspan="2">Daily Total</th> </tr> <tr> <th>IN</th> <th>OUT</th> <th>IN</th> <th>OUT</th> <th>IN</th> <th>OUT</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>8:00</td> <td>12:00</td> <td>1:00</td> <td>4:58</td> <td></td> <td></td> <td>8</td> </tr> <tr> <td>2</td> <td>8:00</td> <td>12:02</td> <td>1:25</td> <td>5:03</td> <td></td> <td></td> <td>8</td> </tr> <tr> <td>3</td> <td>7:59</td> <td>12:01</td> <td>1:00</td> <td>5:01</td> <td></td> <td></td> <td>8</td> </tr> <tr> <td>4</td> <td>7:57</td> <td>12:00</td> <td>1:57</td> <td>5:02</td> <td>5:30</td> <td>8:34</td> <td>11</td> </tr> <tr> <td>5</td> <td>8:01</td> <td>12:02</td> <td>1:59</td> <td>5:00</td> <td></td> <td></td> <td>8</td> </tr> <tr> <td>6</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>7</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>		Days	MORNING		AFTERNOON		OVERTIME		Daily Total	IN	OUT	IN	OUT	IN	OUT	1	8:00	12:00	1:00	4:58			8	2	8:00	12:02	1:25	5:03			8	3	7:59	12:01	1:00	5:01			8	4	7:57	12:00	1:57	5:02	5:30	8:34	11	5	8:01	12:02	1:59	5:00			8	6								7							
Days	MORNING		AFTERNOON		OVERTIME		Daily Total																																																																
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1	8:00	12:00	1:00	4:58			8																																																																
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3	7:59	12:01	1:00	5:01			8																																																																
4	7:57	12:00	1:57	5:02	5:30	8:34	11																																																																
5	8:01	12:02	1:59	5:00			8																																																																
6																																																																							
7																																																																							
Date card this morning to be filled in by the A W Kirkman ITM P on No 0000																																																																							

FIG 8 Combined Attendance Record and Pay Receipt

spaces for an entire week, with a separate space for each morning, afternoon, or night period. The difference between the "In" time and the "Out" time indicates the time the worker has been in the plant each period, and each day's record can be checked against the total elapsed time shown on job tickets turned in for each worker. (See Timekeeping for Cost Purposes, in Section 16.)

In one plant, the clock record is used mainly as an attendance record. On the back of the card are printed the rules governing its use. They are as follows:

- 1 Employees must personally register their time on the clock register.
- 2 Registering for another is considered sufficient cause for dismissal.
- 3 One minute after time for arrival will be considered late.
- 4 Your pay will be made out from this card and you are your own timekeeper.
- 5 No time will be allowed any employee who neglects to register or who registers incorrectly unless he immediately reports same for correction to the foreman.
- 6 Employees accepting this card agree to abide by the above rules.

EMPLOYEES	INSURANCE NUMBER	DATE OF BIRTH	POSITION	EMPLOYMENT	PATROLLA	COMPANY <u>Emerson Corporation</u>		PAYROLL WEEK ENDING <u>Dec 15</u> 19 <u>35</u>	
L. V. FRIEDL	13571445					8812 02 51	8812 03 50	8812 04 21	8812 05 16
B. G. J.	13571445					8812 02 51	8812 03 50	8812 04 21	8812 05 16
Z. G. R. Y.	13571445					8812 02 51	8812 03 50	8812 04 21	8812 05 16

DATE OF BIRTH	1935	SECURITY NO.	Labortone 727	NAME OF PERSON	same
AT	41	ALL OTHERS	38	AT	1506 6

FIG 9 Combined Attendance and Payroll





The top part is detached at the end of the pay period and given to the worker as a pay stub to be cashed. The face of the stub has spaces for the number, period ending and amount. The reverse side reads as follows:

#### PAY RECEIPT

This stub when held by the corporation is considered a receipt for payment of wages for the period indicated. This pay receipt must be cashed only by the owner. If this pay receipt is lost the paymaster must be notified immediately in writing. The corporation will not be responsible for the loss of pay due to the cashing of this pay receipt when presented by the wrong person.

Corporation

**CLOCK CARDS, PAYROLL REGISTERS, AND WORK REPORTS**—It is common practice to provide two card racks, one for "Out" cards on one side of the clock, and one for "In" cards on the other side. These racks are under the eye of a watchman, who also examines badges or identification cards. In the "Out" rack are assembled all cards of employees who are out or not at work. As an employee enters the building he pulls his own card from the "Out" rack, stamps it as he passes the clock, and files it in the compartment bearing his clock number of the "In" rack. On the way out, the process is reversed. The watchman sees to it that only one card is handled by each employee, and that there is no back-tracking or repeating. The racks should be located at a convenient distance from the clock recorder so that employees may take time to select or file their cards without obstructing and delaying the line of registrants.

As a variation of the foregoing procedure, in place of the single large "In" rack beside the clock recorder it is possible to have a smaller "In" rack placed in each department of the plant. When employees arrive for work they select their cards from the "Out" rack at the outer door, stamp the time on the recorder, carry their cards to their department, and leave them in the departmental "In" rack until they go out. This plan has the advantage of showing the foreman in that department whether he has a full working force, or if there are absentees. It is also a practicable procedure where a combined in-and out record and job distribution ticket is used.

A more compact form of attendance record which is also used as a payroll register is shown in Fig 9. The form is used in connection with a dial time recorder.

In the case of field employees, a daily or weekly work report is prepared by the employee himself. This can be combined with a job record (Fig 10) which may also be used as the basis for classifying the employee's time.

**FLOOR CHECK**—In place of an attendance recorder use may be made of a floor check record (Fig 11). The form illustrated serves not only as a summary but as a means of internal check. Downie (N A C A Year Book, 1937) describes its use as follows:









**Mechanical Preparation**—Where a flat rate per payroll period is in force, such as a rate per week, the computation of the base pay offers no serious problem. Where the organization is large enough to warrant the use of addressing or tabulating equipment to prepare skeleton payrolls, the plates, stencils, or cards which are used to imprint the employees' names customarily show also the basic rate of pay for each individual. Corrections and changes in the rates recorded on the plates, stencils or cards are made upon receipt of properly approved payroll change recommendations or employment reports. After each skeleton payroll is run off the mechanically printed basic pay column is added and balanced with the progressive control total established as described in connection with the payroll change recommendation. This internal control minimizes the possibility of unauthorized names on the roll, or tampering with the basic pay rates. The same plates, stencils, or cards are used to head up time clock cards, and other employee records.

**Manual Preparation**—Where mechanical devices are not used, basic rates must be entered on skeleton payrolls and on time clock cards or periodical time and earnings records by hand or typewriter. The source of these entries is a record maintained especially for the purpose, or the rates may be transcribed from the payroll for the preceding period with allowance for any payroll changes approved in the interim. Where the entries are thus transcribed by hand or typewriter it is doubly important to draw off a total of the entries and balance with the control total developed from the payroll change recommendation, so as to detect accidental errors as well as to guard against deliberate manipulation.

**COMPUTING AMOUNT DUE**—Computation of the wages due each worker is the most voluminous and burdensome part of the entire payroll operation. Where the basis of remuneration is a monthly rate a minimum of detail is required; more detail is necessary if the basis is weekly, still more on a daily basis, and approaches a maximum where the basis is an hourly rate. Where payments are made at piece rates or under a group bonus system or other incentive plan, a maximum of detail is required, and the problem of maintaining internal check against a control total becomes most difficult.

Piecework rates are permitted under the Fair Labor Standards Act of 1938 but in that case the rates, the weekly earnings and the number of hours worked during the week must all be recorded so as to prove that maximum hours and minimum earnings are within legal limits.

Computation of actual pay from the basic rates should be made on the time clock card or time and earnings record in accordance with the time reported. Where flat rates of pay are used this merely involves transcribing the rate to the "Regular Pay" column where full attendance is reported. If it is the practice to make deductions for absence or tardiness the calculation can best be made from prepared tables. Likewise, where hourly or piecework rates are in effect, the use of tables is recommended.

**Mechanical Devices**—Although various mechanical devices are used for computing regular and overtime pay the use of prepared tables has been found to be quicker and more accurate. Tables, such as the sample

Per Hr  
Extra Rate **.57**  
28½¢

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
57	0	114	0	228	0	342	0	456	0	570	0	684	0	798	0	912	0	1026	0
58	0	130	0	254	0	368	0	482	0	596	0	710	0	824	0	938	0	1052	0
59	0	146	0	270	0	384	0	498	0	612	0	726	0	840	0	954	0	1068	0
60	0	162	0	286	0	400	0	514	0	628	0	742	0	856	0	970	0	1084	0
61	0	178	0	302	0	416	0	530	0	644	0	758	0	872	0	986	0	1100	0
62	0	194	0	318	0	432	0	546	0	660	0	774	0	888	0	1002	0	1116	0
63	0	210	0	334	0	448	0	562	0	676	0	790	0	904	0	1018	0	1132	0
64	0	226	0	350	0	464	0	578	0	692	0	806	0	920	0	1034	0	1148	0
65	0	242	0	366	0	480	0	594	0	708	0	822	0	936	0	1050	0	1164	0
66	0	258	0	382	0	496	0	610	0	724	0	838	0	952	0	1066	0	1180	0
67	0	274	0	398	0	512	0	626	0	740	0	854	0	968	0	1082	0	1196	0
68	0	290	0	414	0	528	0	642	0	756	0	870	0	984	0	1098	0	1212	0
69	0	306	0	430	0	544	0	658	0	772	0	886	0	1000	0	1114	0	1228	0
70	0	322	0	446	0	560	0	674	0	788	0	902	0	1016	0	1130	0	1244	0
71	0	338	0	462	0	576	0	690	0	804	0	918	0	1032	0	1146	0	1260	0
72	0	354	0	478	0	592	0	706	0	820	0	934	0	1048	0	1162	0	1276	0
73	0	370	0	494	0	608	0	722	0	836	0	950	0	1064	0	1178	0	1292	0
74	0	386	0	510	0	624	0	738	0	852	0	966	0	1080	0	1194	0	1308	0
75	0	402	0	526	0	640	0	754	0	868	0	982	0	1096	0	1210	0	1324	0
76	0	418	0	542	0	656	0	770	0	884	0	998	0	1112	0	1226	0	1340	0
77	0	434	0	558	0	672	0	786	0	900	0	1014	0	1128	0	1242	0	1356	0
78	0	450	0	574	0	688	0	802	0	916	0	1030	0	1144	0	1258	0	1372	0
79	0	466	0	590	0	704	0	818	0	932	0	1046	0	1160	0	1274	0	1388	0
80	0	482	0	606	0	720	0	834	0	948	0	1062	0	1176	0	1290	0	1404	0
81	0	498	0	622	0	736	0	850	0	964	0	1078	0	1192	0	1306	0	1420	0
82	0	514	0	638	0	752	0	866	0	980	0	1094	0	1208	0	1322	0	1436	0
83	0	530	0	654	0	768	0	882	0	996	0	1110	0	1224	0	1338	0	1452	0
84	0	546	0	670	0	784	0	898	0	1012	0	1126	0	1240	0	1354	0	1468	0
85	0	562	0	686	0	800	0	914	0	1028	0	1142	0	1256	0	1370	0	1484	0
86	0	578	0	702	0	816	0	930	0	1044	0	1158	0	1272	0	1386	0	1500	0
87	0	594	0	718	0	832	0	946	0	1060	0	1174	0	1288	0	1402	0	1516	0
88	0	610	0	734	0	848	0	962	0	1076	0	1190	0	1304	0	1418	0	1532	0
89	0	626	0	750	0	864	0	978	0	1092	0	1206	0	1320	0	1434	0	1548	0
90	0	642	0	766	0	880	0	994	0	1108	0	1222	0	1336	0	1450	0	1564	0
91	0	658	0	782	0	896	0	1010	0	1124	0	1238	0	1352	0	1466	0	1580	0
92	0	674	0	798	0	912	0	1026	0	1140	0	1254	0	1368	0	1482	0	1596	0
93	0	690	0	814	0	928	0	1042	0	1156	0	1270	0	1384	0	1498	0	1612	0
94	0	706	0	830	0	944	0	1058	0	1172	0	1286	0	1400	0	1514	0	1628	0
95	0	722	0	846	0	960	0	1074	0	1188	0	1302	0	1416	0	1530	0	1644	0
96	0	738	0	862	0	976	0	1090	0	1204	0	1318	0	1432	0	1546	0	1660	0
97	0	754	0	878	0	992	0	1106	0	1220	0	1334	0	1448	0	1562	0	1676	0
98	0	770	0	894	0	1008	0	1122	0	1236	0	1350	0	1464	0	1578	0	1692	0
99	0	786	0	910	0	1024	0	1138	0	1252	0	1366	0	1480	0	1594	0	1708	0
100	0	802	0	926	0	1040	0	1154	0	1268	0	1382	0	1496	0	1610	0	1724	0
101	0	818	0	942	0	1056	0	1170	0	1284	0	1398	0	1512	0	1626	0	1740	0
102	0	834	0	958	0	1072	0	1186	0	1300	0	1414	0	1528	0	1642	0	1756	0
103	0	850	0	974	0	1088	0	1202	0	1316	0	1430	0	1544	0	1658	0	1772	0
104	0	866	0	990	0	1104	0	1218	0	1332	0	1446	0	1560	0	1674	0	1788	0
105	0	882	0	1006	0	1120	0	1234	0	1348	0	1462	0	1576	0	1690	0	1804	0
106	0	898	0	1022	0	1136	0	1250	0	1364	0	1478	0	1592	0	1706	0	1820	0
107	0	914	0	1038	0	1152	0	1266	0	1380	0	1494	0	1608	0	1722	0	1836	0
108	0	930	0	1054	0	1168	0	1282	0	1396	0	1510	0	1624	0	1738	0	1852	0
109	0	946	0	1070	0	1184	0	1298	0	1412	0	1526	0	1640	0	1754	0	1868	0
110	0	962	0	1086	0	1200	0	1314	0	1428	0	1542	0	1656	0	1770	0	1884	0
111	0	978	0	1102	0	1216	0	1330	0	1444	0	1558	0	1672	0	1786	0	1900	0
112	0	994	0	1118	0	1232	0	1346	0	1460	0	1574	0	1688	0	1802	0	1916	0
113	0	1010	0	1134	0	1248	0	1362	0	1476	0	1590	0	1704	0	1818	0	1932	0
114	0	1026	0	1150	0	1264	0	1378	0	1492	0	1606	0	1720	0	1834	0	1948	0
115	0	1042	0	1166	0	1280	0	1394	0	1508	0	1622	0	1736	0	1850	0	1964	0
116	0	1058	0	1182	0	1296	0	1410	0	1524	0	1638	0	1752	0	1866	0	1980	0
117	0	1074	0	1198	0	1312	0	1426	0	1540	0	1654	0	1768	0	1882	0	1996	0
118	0	1090	0	1214	0	1328	0	1442	0	1556	0	1670	0	1784	0	1898	0	2012	0
119	0	1106	0	1230	0	1344	0	1458	0	1572	0	1686	0	1800	0	1914	0	2028	0
120	0	1122	0	1246	0	1360	0	1474	0	1588	0	1702	0	1816	0	1930	0	2044	0
121	0	1138	0	1262	0	1376	0	1490	0	1604	0	1718	0	1832	0	1946	0	2060	0
122	0	1154	0	1278	0	1392	0	1506	0	1620	0	1734	0	1848	0	1962	0	2076	0
123	0	1170	0	1294	0	1408	0	1522	0	1638	0	1752	0	1866	0	1982	0	2092	0
124	0	1186	0	1310	0	1424	0	1538	0	1654	0	1768	0	1882	0	1998	0	2108	0
125	0	1202	0	1326	0	1440	0	1554	0	1670	0	1784	0	1898	0	2014	0	2124	0
126	0	1218	0	1342	0	1456	0	1570	0	1686	0	1800	0	1914	0	2030	0	2140	0
127	0	1234	0	1358	0	1472	0	1586	0	1702	0	1816	0	1930	0	2046	0	2156	0
128	0	1250	0	1374	0	1488	0	1602	0	1718	0	1832	0	1946	0	2062	0	2172	0
129	0	1266	0	1390	0	1504	0	1618	0	1734	0	1848	0	1962	0	2078	0	2188	0
130	0	1282	0	1406	0	1520	0	1634	0	1750	0	1864	0	1978	0	2094	0	2204	0
131	0	1298	0	1422	0	1536	0	1650	0	1766	0	1880	0	1994	0	2110	0	2220	0
132	0	1314	0	1438	0	1552	0	1666	0	1782	0	1896	0	2010	0	2126	0	2236	0
133	0	1330	0	1454	0	1568	0	1682	0	1798	0	1912	0	2026	0	2142	0	2252	0
134	0	1346	0	1470	0	1584	0	1698	0	1814	0	1928	0	2042	0	2158	0	2268	0
135	0	1362	0	1486	0	1600	0	1714	0	1828	0	1942	0	2056	0	2172	0	2284	0
136	0	1378	0	1502	0	1616	0	1730	0	1844	0	1958</							

shown in Fig 14, can be purchased or constructed to cover not only straight salary rates but also bonus, differential, or piecework rates to suit the needs of a particular business. Another scheme is to superimpose a time card upon a matching payroll table. This method is particularly well adapted to the evaluation of elapsed time on job records, and is described in detail in Section 16, under "Timekeeping for Cost Purposes."

**ADDITIONS TO BASE PAY**—The computation of earnings at this point is preparatory to making the actual cash payment. It should cover every item to be included in the pay envelope or on the pay check. Typical items are regular and overtime pay, also any additional allowances granted for Sunday, holiday or night work, carfare allowances, commissions, regular periodical bonuses, or bonuses based on production accomplishments.

**Bonus Payments**—Bonuses are usually figured weekly, though many plants compute them daily. They are intended generally as an incentive to greater production and their value for this purpose is lost unless each workman is shown clearly the relation between his production and his bonus. It is good practice to insert a bonus slip in the pay envelope to show how the bonus was computed.

However, many plants prepare and distribute to the workers bonus tickets every day. This is done on the principle enunciated by F. W. Taylor that best results of an incentive scheme are obtained when rewards are immediate. A daily reminder is a stimulant to the worker to continue good work or to improve a subnormal performance. Another advantage of daily bonus tickets lies in the fact that if errors occur they can be corrected before pay day. Corrections are easier because, in case of dispute, the facts are fresh in every one's mind.

**Reimbursements for Expenditures**—Items such as carfare allowances or per diem allowances on occasional trips away from home which are in the nature of reimbursement for expenditures made on behalf of the company are not "earnings" even though they may be included in the pay check as a matter of convenience in paying. These amounts should be excluded from taxable totals and from calculations of earnings to determine compliance with the Fair Labor Standards Act.

All of the foregoing additions to pay are recorded on the individual's time and earnings record. This form may be varied in endless ways to meet local payment practices, provided it shows clearly a summary of the hours worked each week and the cash compensation therefor. (See discussion later in this Section.)

## Constant Deductions from Pay

**TYPES OF DEDUCTIONS**—A distinction should be made between those deductions which are constant period after period, and those which are variable. Constant deductions are usually the result of a voluntary authorization made by the employee in accordance with the terms of a plan formally announced by the company. The announcement of the plan should describe clearly

- 1 The purpose of the deductions
- 2 The method by which the employee authorizes deductions
- 3 Disposition of the funds by the company
- 4 The method by which the employee may withdraw from the arrangement

Deductions other than those required by law must be authorized by the employee. An interesting form of authorization capable of dealing with the constantly lengthening list of payroll deductions is the use of a strip waiver consisting of one lengthy, perforated form which is prepared at the time the applicant is filling out his personal information card. For convenience a summary of deductions (Fig 15) is prepared from these authorizations, it should be made out for each individual involved and used as the basis for recording deductions on the employee's earnings record and check stub. These forms should be maintained in the same order in which the earnings records are filed.

John E. Doe				2455			
RECORD OF AUTHORIZED PAYROLL DEDUCTIONS							
COVERMEN LIFE INSURANCE	OWNERS LIABILITY INSURANCE	HOSPITAL ACCIDENTATION	LOANS	ASSOCIATION DUES	U.S. SAVINGS BONDS	COMMUNITY CHEST	SALAR ADVANCES
1.00	1.25	.50					
.50	2.00	1.0					
DEDUCTION IS NOT MADE DUE TO INSUFFICIENT PAY							
PERIOD ENDED	PLAN	AMOUNT	DISPOSITION	PERIOD ENDED	PLAN	AMOUNT	DISPOSITION

FIG 15 Authorized Deductions Card

**SCHEDULE OF DEDUCTIONS**—Constant deductions do not vary in amount, although they may not occur every week. Some are made only monthly, and the weekly deductions may or may not be made when a fifth pay day occurs in a month. A schedule of such deductions is maintained and observed, spreading the deductions as evenly as possible for example

1ST AND 4TH SATURDAY  
Commercial Insurance  
Savings Bank  
U S Savings Bonds

2ND SATURDAY  
Commercial Insurance  
Savings Bank  
U S Savings Bonds  
Hospitalization

3RD SATURDAY  
Commercial Insurance  
Savings Bank  
U S Savings Bonds  
Union Dues

5TH SATURDAY  
Savings Bank  
U S Savings Bonds

The schedule may be incorporated as part of the employee earning record (Fig. 12)

The instructions contained in the announcements of the various plans should clearly indicate which deductions are given priority in the event the pay is insufficient to warrant making all deductions

**SECURITY PURCHASES**—A sound plan for handling deductions for security purchases is outlined by Bruce (NACA Bulletin, vol 24). Although the plan is designed for the purchase of U S war bonds it may be applied with modifications to the purchase of any securities. Each plan for a constant voluntary deduction from pay should provide four fundamental features in addition to the initial announcement of the plan

- 1 Authorization—provision of a form on which each employee can voluntarily state his wishes and authorize deductions
- 2 Deduction—establishment of some mechanism to insure regular and accurate deduction from pay
- 3 Records of amounts accumulated and amounts applied to the purpose of the plan
- 4 Disposition of funds—a method of applying the accumulation of deductions to the purposes of the plan

**Authorization**—Authorization cards whether privately prepared or in the case of government bonds obtainable from the Treasury Department, show the name of the employee and of the company concerned. It also contains an authorization for the deduction of a specified amount, when allotments begin and what denominations of bonds the employee desires to purchase. Provision is also made for showing the manner in which the employee wishes to have the bonds registered. The final paragraph of the text on the face of the card constitutes an acknowledgment of receipt of a copy of the printed plan, which the employer has distributed. Verbal descriptions of plans are not desirable. Finally, the necessary space is provided for the employee's signature.

**Deduction Procedure**—A mechanism for regular and accurate allotments of pay cannot be standardized. The form it takes depends upon the payroll procedure already used in each establishment. Some concerns prepare their payrolls by means of tabulating machines, others use bookkeeping and check-writing machines, and still others use strictly manual methods. However the following check list of requirements must be met in every case

- 1 There must be some way to notify the payroll clerk to make the deductions
- 2 Some place must be provided on a suitable form on which the payroll clerk can compute and record the net amounts of pay due after the deductions are made
- 3 Some means of control must be established to provide a total with which the calculating work may be balanced
- 4 A means of safekeeping the funds withheld must be provided which

NAME		DEPT & LOCATION		DEDUCTION		PAY-ROLL PERIOD		1st DEDUCTION		ISSUE PRICE																						
												YEAR 13		YEAR 13																		
												1	2	3	4	5	6	7	8	9	10	11	12									
M	1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
O	2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
T	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
W	4	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
TH	5	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
J	6	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
F	7	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
M	8	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
T	9	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
W	10	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
TH	11	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
J	12	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
A	13	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
S	14	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
O	15	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
N	16	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
D	17	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
J	18	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
F	19	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
M	20	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
T	21	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
W	22	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
TH	23	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
J	24	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
A	25	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
S	26	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
O	27	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
N	28	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
D	29	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
J	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
F	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

Fig 16 Record of Payroll Deductions for Security Purchases

may involve bonding the employee who makes the deductions and which should always include the establishment of a separate trust fund bank account apart from the company's own corporate funds.

- 5 Provision must be made for preparing a list of the deductions made each pay period which serves as a permanent journal record of the transactions and as a basis for the ledger postings.

**Records of Amounts Accumulated and Applied**—According to Bruce (NACA Bulletin vol 24), the best procedure in the case of war bond purchases is to use a record such as that shown in Fig 16, which is printed on the reverse side of the authorization card. This is true whether a company is a very large one using a highly mechanized method of payroll preparation, or whether it is a very small concern whose records are prepared entirely on a manual basis. In this way the employee's statement of his wishes, and the records of their execution for a period of six years are all placed on the same form. The record in card form gives the utmost in flexibility, so that subscribers may be added or removed and the authorizations may be changed, without affecting the system.

The sequence of the cards in the file may be alphabetical or numerical, or by departments or any other way which keeps them in agreement with the sequence of the names appearing on the payroll clerk's deduction lists. There should be a card for every item on the deduction list and an item for every card, arranged in the same sequence. Irregularities occur only when some change in authorization has not been properly put into effect.

At the top of each card, under the caption "Deduction" the amount of the payroll deduction is shown. This should exactly agree with the amount shown on the payroll clerk's deduction list. Since everything is in exact agreement, the only posting necessary is to put a check mark in the proper space under the caption "Payroll Period." If desired the actual amount of the deduction may be entered in the column provided under "Payroll Periods," although it has been found that a simple check mark is entirely adequate so long as the amount of the deduction is shown at the top of the card. If the amount of the deduction is changed the new amount is posted only the first time to mark the point of change. Provision is made on the form for five weekly payroll periods in a month. If payments are made weekly, some months have four and some have five deductions. If payrolls are prepared semi-monthly, only the first and second spaces are used each month.

It is desirable to balance the file once each month. This is done by computing and entering "Net Credit End of Month" on each card. For example, in a month with four payroll periods, where the weekly deduction is 75 cents, four check marks mean that \$3.00 has been accumulated during the current month, and this added to the net credit at the end of the preceding month gives the net credit at the end of the current month. An adding machine total of the latest "Net Credit End of Month" on all cards in the file must exactly equal the balance in the special bank account at the close of the month. A further reconciliation can be made in accordance with the following formula. Total credit in bank end of previous month, plus total deductions per the month's payrolls less the month's remittance for bond purchases, equal the net credit at the end of the month.



- 1 Per sum of cards
- 2 Per bank balance

Note that in the foregoing reconciliation it was necessary to take into account the remittance for bond purchases during the month. A column caption "Applied to Purchase of Bond" is provided on the card record for recording the details of such purchases. The entries in this column are posted from a bond purchase list.

**Purchase and Delivery of Bonds**—The most commonly used method in connection with payroll savings plans is to order the bonds directly from the local Federal Reserve Bank. Bonds purchased in this way are delivered directly to the employees by registered mail. It is also possible to order bonds through the local post office, in which case delivery may be obtained either across the counter or directly to the employee by registered mail. This is the method used by many smaller concerns, particularly outside the larger metropolitan areas. The third method is to purchase bonds through any other authorized issuing agent. Where issuing agents other than Federal Reserve Bank or the local post office are utilized, delivery of the bond is usually made by hand, and some form of acknowledgment of receipt by the employee must be provided.

When deductions begin, the bookkeeper computes the month in which the purchase of the bond should normally be made and this is marked on the card by inserting a dollar sign opposite that month in the column headed "Applied to Purchase of Bond" (Fig. 16). This serves as an effective reminder to warn the bookkeeper when the purchase date arrives.

The order form is ordinarily prepared by the employer in triplicate. The original order goes to the issuing agent, the duplicate is for the employer's own records. The triplicate copy can be detached and inserted in the employee's pay envelope as a notification that the bond has been ordered. A single check to the order of the Treasurer of the United States may be drawn for the total purchase value of all bonds ordered at one time.

**THRIFT PLAN FOR SAVINGS BANK DEPOSITS**—Three of the features discussed above under "Security Purchases" must be provided, with suitable variations, in setting up a savings bank plan, viz.,

- 1 A printed announcement of the terms of the plan
- 2 An authorization form on which the employee can state his wishes and authorize deductions
- 3 Some mechanism to insure regular and accurate deductions from pay

In this case, however, the matters of record keeping and disposition of funds withheld are somewhat different.

Usually there is an arrangement with the bank whereby a list of participants, showing the amounts of their periodical deposits, is prepared each pay period and used as a blanket deposit slip. Where procedures are mechanized, this is done by an adding-machine or tabulating machine listing. A duplicate copy of this list comprises the company's record, and no cumulative record is maintained. After the deposit

is made each pay day the employee has full control of the funds just as if he had personally made the deposit, and the company's interest ends just as if the money had been paid to the employee in cash. The bank usually sends the employee a statement of account at stated intervals.

**LIFE ACCIDENT, OR HOSPITALIZATION INSURANCE PREMIUMS**—Usually there is an arrangement with an insurance company whereby a list of participants and the periodical premiums is prepared at intervals to accompany a check for the premium payments. There is the difficulty, however, that payrolls may be paid weekly and insurance premiums are due monthly. This condition is usually met by arranging for deduction of insurance premiums only on a certain single pay day each month. Where it is necessary to make a small deduction every week two problems are introduced:

- 1 Employer acts as custodian of the funds in the interval between the weekly pay day and the date of the premium remittance to the insurance company.
- 2 Weekly instalments do not always equal the monthly premiums.

**Custodianship**—A separate bank account must be established for this purpose as a trust fund, so that accumulations for payment of insurance premiums are not intermingled with company funds. If the amounts involved are too small to justify a separate bank account, at least a separate account in the general ledger should be provided clearly indicating that the funds are held in trust for employees. Normally the monthly premium payment reduces the account to zero so no elaborate subsidiary ledger is needed. The four weekly deduction lists and the one monthly remittance list stapled together and filed, constitute an adequate record of the transactions.

**Irregularities**—About one month in each quarter contains five pay days, whereas four instalments suffice to pay the premium. This condition is met simply by omitting deductions on the fifth pay day of a month. Differences due to adding or removing employees during the month are avoided by providing in the plan that all deductions shall begin on the first pay day of the month following the date the employee signs the authorization and that when the arrangement is terminated in the middle of a month all deductions made since the close of the preceding month are paid to the employee in cash.

This leaves only irregularities due to failure to deduct enough to cover the premiums, e.g., where the employee is absent for a week without pay. To prevent lapse of insurance coverage every such case should be watched carefully. The plan may provide for payment of the missing amount by the employee to the employer in cash, or in distress cases the employer may arrange to advance the amount and collect from the employee at some future date. Such advances are charged to Accounts Receivable or Notes Receivable, as appropriate with suitable supporting documents, and not left to appear as a debit in the Employees' Insurance Premiums Payable account (Fig. 17).

**ASSOCIATION DUES**—Association dues or check-off of union dues are handled much the same as insurance premiums. Instead of the arrangement being entirely voluntary and evidenced by an authorization

signed by the individual employee, there may exist a blanket closed shop agreement which makes the deduction obligatory for all employees. There is also the custodianship feature, as described in connection with insurance premium deductions, if deductions are made weekly and remittances to the association or union are made monthly. This should be avoided wherever possible either by remitting weekly or by withholding only on one pay day of every month.

I Correct Method			II Incorrect Method		
SALARY DISTRIBUTION			SALARY DISTRIBUTION		
(a)	\$50 00		(a)	\$50 00	
GENERAL CASH			GENERAL CASH		
		(a) \$31 00		(a)	\$31 00
		(b) 6 00		(c)	6 00
		(d) 2 00			
EMPLOYEES' PREMIUMS PAYABLE			EMPLOYEES' PREMIUMS PAYABLE		
(c)	\$ 8 00	(a) \$ 6 00	(c)	\$ 8 00	(a) \$ 6 00
		(c) 2 00			
SPECIAL TRUST ACCOUNT					
(b)	\$ 0 00	(c) \$ 8 00			
(d)	2 00				
ACCOUNTS RECEIVABLE—EMPLOYEES					
(c)	\$ 2 00				
Explanations			Explanations		
(a)	Payroll entries 3 weeks at \$30 each		(a)	Payroll entries 3 weeks at \$30 each	
(b)	Deposit in special trust bank to count 3 weeks at \$2 each		(c)	Payment of premium 4 weeks at \$2 each	
(c)	Loan for 4th week \$2				
(d)	Deposit of loan for 4th week \$2				
(e)	Payment of premium, 4 weeks at \$2 each				

FIG. 17 Correct and Incorrect Methods of Recording Advance to Cover Employee's Insurance Premiums

## Variable Payroll Deductions

**TYPES OF VARIABLE DEDUCTIONS**—Variable deductions from pay may vary in the following ways

- 1 There is no relation between the deduction and total pay, as in the case of absence or tardiness penalty for spoilage etc.
- 2 From one pay period to the next when they are calculated as a percentage of variable earnings.
- 3 From one season of the year to another when they involve either initial exemptions and later surtaxes as in the case of personal income taxes, or when they involve ultimate ceilings as in the case of old age benefit taxes.

**ABSENCE OR TARDINESS**—Deductions from pay because of absence or tardiness should be taken into account when base pay is computed, and should be incorporated in the time and earnings record previously described.

**OLD AGE SURVIVOR BENEFITS**—The rate applied is a constant, with no surtaxes and the only factor to watch is the ceiling limit of \$3,000. After the years earnings have reached this point, no further deductions are made. There are two common methods of watching for this ceiling. In some payroll machine applications a reducing balance is used on the individual earnings record. A column headed "Balance Subject to Old Age Benefit Tax" is provided and the initial amount set up on January 1, is \$3,000. As the earnings for each pay period are posted, they are subtracted from this column. The tax for the next pay period is computed on either (1) the pay for the period, or (2) the previous "Balance Subject to Old Age Benefit Tax," whichever is lower. When the latter column is reduced to zero, deductions cease.

The other method is to record cumulative earnings on the individual earnings record and watch these each pay period when the \$3,000 maximum is approached. In the pay period in which \$3,000 is about to be passed, a special calculation of the final tax deduction must be made.

With the old age benefit tax rate set at one per cent, no calculating operation is involved, except in the final period as just described because merely shifting the decimal point gives the amount of tax. However, the law provides for progressive increases in the rate first to 2% and finally to 3%. This can best be taken care of by providing a tax column on the time clock card or the time and earnings record. The tax figure is then readily available for use in processing the payroll itself.

**UNEMPLOYMENT INSURANCE**—In some states employees are required to contribute toward the state unemployment insurance funds. Hence a calculation of the tax is necessary on the time clock card, time and earnings record, or other source document used in payroll preparation. The procedure is the same as for old age benefit taxes.

**STATE AND FEDERAL PERSONAL INCOME TAX WITHHOLDINGS**—In some states, personal income taxes must be withheld from employees' pay by their employers, particularly in cases where an employee is a resident of a different state from the one in which he works. The same problem is presented in any withholding tax requirement, such as the various federal withholding taxes.

Although no signed authorization is required of the employee to start deductions for personal income taxes, a signed statement of personal exemptions is usually necessary to determine the starting point of tax deductions each year. The amount of personal exemption claimed by the employee is posted to his earnings record.

Where earnings are reasonably constant, as in the case of employees working on straight salary, it is desirable to apportion the total income tax for the year as evenly as possible over the remaining pay days of the year after personal exemptions have been earned. First divide the amount of personal exemptions by the average earnings per pay period to determine how many pay periods must pass without deductions. Next estimate the total income tax for the year, including any surtaxes, and divide this by the remaining number of pay periods to determine the amount to be deducted each period. Under this method if an employee leaves the service before the end of the year his actual income tax up to date of leaving must be calculated, and a refund made for

the excess previously deducted. There is normally an excess because in the initial calculations it was assumed that surtaxes are effective late in the year, and these do not become fully operative if the employee leaves before the end of the year. Only as a last resort should the practice be adopted of calculating the actual income tax deduction each pay period. This involves so much work that it is practically prohibitive for the employer, and furthermore, the mounting deductions as successive surtaxes become operative later in the year make this practice very burdensome for the higher paid employees.

**Changes of Income Tax Status**—A change of status during the year, such as a pay increase or a change in number of dependents necessitates a recalculation of the tax deduction rate. Total taxes for the year, as recalculated, minus taxes already deducted divided by the remaining pay periods in the year, gives the new deduction rate per pay period. At the beginning of the final quarter, also at the beginning of December and just before the final pay period, it is advisable to review all earnings records which involve state income tax deductions to insure that adequate deductions are being made to cover any changed conditions such as pay increases, bonuses, larger overtime payments than were originally estimated, etc. While it is desirable to have the deductions as nearly correct as possible, any unavoidable variation, due to the necessity of using estimated earnings figures, should be on the side of excess deductions which can be refunded at the close of the year, rather than on the side of underdeductions which may be difficult to collect at the year's end.

**Flat Rate Deductions**—Where earnings are highly irregular or where labor turnover is high, such a deduction as a state income tax is very difficult to administer. If labor relations are such as to permit it, a flat rate deduction may be used sufficiently high to cover an employee's maximum estimated earnings with the excess returned upon termination of employment or at the year's close.

## Preparation of Payrolls

**FUNCTIONS OF PAYROLL DEPARTMENT**—It is impossible to standardize the functions of a payroll department since these are bound to vary, depending upon local conditions. In some plants the payroll department is a special division of the cost accounting department, in others it is an adjunct to the factory office. The following list of payroll department functions is, therefore, only suggestive.

- 1 Determine regular and overtime hours
- 2 Check and enter all wage rates
- 3 Compute regular and overtime pay
- 4 Compute additions to base pay
- 5 Calculate and post bonuses and make out, if necessary, bonus tickets. These calculations may be required daily, weekly, monthly or at other intervals.
- 6 Prepare and compute the requisite payroll deductions
- 7 Calculate and enter net pay

- 8 Prepare all necessary documents in connection with the payroll
  - a Payroll register
  - b Individual annual earnings record
  - c Pay check or pay envelope
  - d Statement of earnings and payroll deductions accompanying pay check or pay envelopeIn some cases the payroll check register is also prepared by the payroll department
- 9 Handle and prepare other records not part of the double entry system but which are made necessary by law or other requirement (this includes reports and returns required by government agencies)
- 10 Prove all subsidiary records against control totals and check and balance out each original record both as to dollar amounts and hours and sometimes quantities of production
- 11 Deliver payroll checks to the proper persons for distribution to the workers on pay day. While payment is made in cash the audited payrolls are turned over to the paymaster for final processing (see discussion later in this Section)
- 12 Transfer necessary records and data to
  - a Controller general accounting department paymaster
  - b Cost department

**NECESSITY FOR ACCURACY**—The payroll represents the most tangible point of contact with employees. Hence, its accuracy is all important, it is less difficult to recover from an error of judgment in personal approach to an employee, than from an error committed in payment of his wages. Since errors are almost sure to occur from time to time, the human element should be removed as far as possible by the use of automatic and mechanical equipment. In case such equipment is not feasible, control devices must be set up so that even if the system is manually operated, errors are eliminated or kept at a minimum. Use of automatic or mechanical equipment makes it practicable to furnish employees with a statement of certain details as to the make-up of the net pay. This becomes more important with the tendency to increase the number of pay deductions for taxes, thrift, insurance, and various other purposes.

**RECORDS OR DOCUMENTS USED**—Three records or documents are usually prepared simultaneously. This is true in general of mechanical bookkeeping installations, and even of some manual systems.

- 1 The payroll
- 2 Either the pay check or the pay envelope, depending upon whether payments are made by check or in cash, including a statement of earnings for the employee's information
- 3 The individual annual earnings record

**Payroll**—The following information required under the Fair Labor Standards Act of 1938 can conveniently be recorded on the payroll:

- 1 Name in full
- 2 Occupation
- 3 Hour and day on which work week begins (at top of sheet if the same for all employees or on individual lines if different for different employees)
- 4 Basis on which wages are paid
- 5 Total straight time earnings



NAME		DATE		HOURS		GROSS		DEDUCTIONS		NET	
NO		DATE	NO	TO	FROM	TAX	INS.	UNEMP.	RET.		
<p>HOMER WARREN &amp; COMPANY DETROIT MICH</p> <p><b>PAY CHECK</b></p> <p><b>HOMER WARREN &amp; COMPANY</b> MANAGING AGENTS <b>FORD BUILDING DIME BUILDING</b> DETROIT MICHIGAN</p> <p><b>No</b></p> <p>PAY TO THE ORDER OF _____ \$ _____</p> <p><b>COMMONWEALTH BANK</b> 9-31 DETROIT MICHIGAN</p> <p>THIS CHECK IS NOT VALID DRAWN FOR OVER \$ 50.00</p> <p><b>C9-922</b></p> <p><b>HOMER WARREN &amp; COMPANY</b> DIME BUILDING FAY ROLL ACCOUNT</p>											

DETACH THIS STATEMENT FROM CASH NO. A. D. RETAIN A. YOUR RECORD

Fig 19 Pay Check with Attached Employee Earning Statement



- 6 Overtime compensation
- 7 Other additions to or deductions from wages paid
- 8 Total wages paid
- 9 Date of payment
- 10 Period covered by payment

Similar or supplemental required information shown on employee's service record, attendance time record or individual annual earnings record must be in agreement. The payroll may also include other information according to the particular concern's requirements, such as clock number, check number if payment is made by check, factory or department location, etc. The payroll sheet (Fig. 18) is ordinarily designed in columnar form with a view towards using a summary of the column totals as support for the journal voucher showing charges to control accounts in the general ledger. The size and form of this record vary with the size and nature of the business and with the kind of mechanical devices used in its preparation.

**Pay Checks**—Pay checks are prepared on prenumbered stationery. The stationery stock is kept under lock and key in custody of a responsible official and disbursed to the payroll clerk only as required. Accountability for every check number must be established. Spoiled checks are returned to the custodian of the blank checks who voids them and keeps them in numerical order subject to audit. They should not be destroyed prior to audit.

Usually pay checks are provided with stubs either at one end or along the top or bottom margin, on which the elements which make up the net pay are shown, e.g., base pay, overtime or bonus and each of the deductions (Fig. 19).

**Pay Envelopes**—Pay envelopes should be prepared by addressing machine if the list of employees is so kept. Usually the face of the envelope provides space for showing the elements which make up the net pay and frequently the envelope flap is designed to be detached and used as the employee's acknowledgment of receipt (Fig. 20).

**Individual Annual Earnings Record**—The individual annual earnings record (Fig. 21) is used both as a source medium for some postings and to receive a copy of other postings. The upper portion of the form is posted, at the time the employee is hired, from the payroll change recommendation or employment report supplemented by the accompanying service record. Subsequent changes are posted from approved payroll change recommendations, deduction authorizations, etc.

This earnings record serves, when each payroll is prepared, as the source for such constant figures as basic wage rates and fixed deductions, as in Fig. 12. The following information required under the Fair Labor Standards Act of 1938 can conveniently be recorded on the individual annual earnings record:

- 1 Name in full
- 2 Occupation
- 3 Basis on which wages are paid
- 4 Additions to or deductions from wages paid
- 5 Total wages paid each pay period
- 6 Period covered by payment
- 7 Total weekly straight time earnings
- 8 Total weekly overtime compensation

PAY ROLL RECEIPT	
Employee's Name	Lewis Spencer
Employee's No	
Received From	SILVER TAXI CO. (Employer)
Date Paid	March 9, 19__
Hours Worked	Reg 48 Overtime Total 48
Amount Earned	\$ 21.00
Commissions	\$ 15.00
Total	\$ 36.00
DEDUCTIONS:	
Fed. & Cal. Age	1 % \$ .36
State Tax	
Uniform	\$ 1.00
	\$
	\$
Total Deductions	\$ 1.36
Net Amount Herewith	\$ 34.64
<i>Lewis Spencer</i>	
EMPLOYEE SIGN HERE	
STANDARD FORM 6708E SH & S R ET O PATRONSBERG	

FIG 20 Pay Envelope

Deductions must be itemized, or supported by supplementary records which can readily be reconciled with the payroll entry. Similar or supplemental required information shown on the employee's service record, attendance time record or payroll, must be in agreement with the individual annual earnings record.

The lower portion of the earnings record (Fig. 21) shows cumulative total earnings for the quarter and the year. The form can be made to show the reducing balance subject to old age benefit tax where this method is in use. Under some machine accounting procedures this portion receives postings showing the complete make-up of each pay check or envelope.

In the pay period in which an employee's earnings become exempt from social security taxes because the \$3 000 limit of taxable wages is reached, entries should show separate amounts for:

- 1 Taxable wages up to the \$3 000 point.
- 2 Wages exempt because they exceed the \$3 000 limit.

A column should also be provided for special payments, which are part of taxable income but are not included in the regular pay check, such as bonuses, prizes, etc., and payments made by means other than cash. This should include the reasonable cost (excluding profit to employer) of forms of compensation such as free lunches, free rent or heat, prizes in the form of merchandise, etc., which must be recorded for unemployment insurance, personal income tax and victory tax purposes and perhaps for inclusion in any computations to prove compliance with minimum earnings provisions of the Fair Labor Standards Act of 1938. It should also include vacation compensation adjustments and any other special payments on account of termination of employment. Appropriate explanation as to the nature and approval of any such forms of compensation should be shown as a footnote or entered on the reverse side of the form.

In order to assist in balancing the entries on the individual annual earnings record with taxable earnings totals as reported to government agencies, special attention must be paid to the filing of records. The original order of the forms is retained and no form is removed from its original location in the sequence established. Generally it is found advantageous to make up a new card when any employee is transferred from one state or payroll unit to another. When an employee enters or leaves the service or when his record is transferred to another card, a diagonal line is drawn from the first or last weekly space in which his pay was computed to the corner of the card, and appropriate cross references to other cards are made. A notation is added showing sufficient explanation of the circumstances, e.g., "Resigned (date)," "Transferred to (location or unit)" etc.

## Preparation of Records

**ADDRESSING MACHINES**—Since many types of payroll equipment cannot be used for typing names on checks or payrolls, the names on the checks and entries in the "Name" column of the payroll must be entered in advance in longhand by typewriter, addressing machine, or duplicator. Use of an addressing machine is strongly recommended wherever practicable, as an adjunct to nonalphabetic payroll machines and in all manual installations. An example of the information contained on addressing machine plates or stencils is shown in Fig. 12. This includes payroll number, department or location, base rate of pay,



authorized fixed deductions, social security number, clock number, occupational code, sex, date of birth, date of employment, or other personnel data useful in compiling various statistics reports, and records in addition to the payroll and pay check or envelope. Most addressing machines are equipped with devices which can be used to block out information not wanted on any document, thus the pay check or pay envelope may be printed from such a stencil to show only the name while the payroll may include social security number, clock number and base pay and the heading of the individual annual earnings record may show a complete impression of the plate or stencil.

The use of Addressograph plates in the case of the River Rouge Plant of the Ford Motor Co. is described by French (*American Business* vol 13)

**Controlling the Addressing File**—Plates or stencils are originally prepared from the payroll change recommendation or employment report in combination with the accompanying service record. Subsequent changes in the stencils are made from approved payroll change recommendations. The best practice where payrolls are large, provides for the following sequence of controlled operations:

- 1 Stencils are removed from active files for all items listed on payroll change recommendation or on a supporting list of payroll changes under the caption "Old."
- 2 Listing of these stencils is made on proof tape; the weekly rates are added and balanced with total of old rates on the summary list of payroll changes.
- 3 Changes in these stencils are made as required by entries under "New" on payroll change recommendation. Stencils for such items as "Resigned," "Laid Off," etc., are destroyed. Stencils for "Engaged" are originated with the aid of information shown on the accompanying service record. Stencils for names transferred from one payroll to another are shifted to the appropriate file.
- 4 After all changes are completed, stencils for "Engaged," "Transferred In," and wage rate changes are listed on proof tape; weekly rates are added and balanced with total of new rates on the summary list of payroll changes.
- 5 These corrected and new stencils are then interfiled among the unchanged plates.

- 6 Payroll for the next period is then addressed weekly rates are added from the stencil impressions and the total is balanced with the new control total at the bottom of the summary of payroll changes

**Use of Payroll Stencils**—Payroll stencils are useful for preparing the necessary number of copies of such documents as those listed below

- 1 Alphabetic (name) portion of pay check or pay envelope
- 2 Listing of name base rate of pay etc on payroll
- 3 Heading of individual annual earnings record
- 4 Heading of time clock cards
- 5 Alphabetic (name) portion of pay receipts
- 6 Detail of authorized salary deductions each pay period
- 7 Deposit slips in connection with savings bank plans
- 8 Premium lists in connection with individual insurance plans
- 9 Name and social security account number on quarterly payroll reports for old age benefit or state unemployment insurance purposes
- 10 Alphabetic (name) portion of any withholding tax receipts

In connection with the preparation of each class of documents mentioned above control totals of the number of items and of the total amounts involved are maintained on special records. Fig 22 illustrates a type of control record for authorized deductions. The control record is kept up to date by adding or subtracting the amounts of changes entering the new amounts and dates effective in the next space on the card. Each set of impressions is counted and added, and balanced with these controls. Any longhand additions, deletions or alterations in the lists released from the addressing department should be subjected to careful scrutiny in the course of any audit which may be made of the payroll records to insure that the changes are properly authorized or otherwise in accordance with the facts. The value of addressing machines as a means of internal check on the preparation of payroll documents cannot be overemphasized.

**PREPARING EARNINGS RECORD**—Traditionally, where the earnings record, pay check and payroll are prepared separately, the payroll is prepared first as the work sheet, this serves as the source medium for drawing off the figures required to complete the other documents. However, the individual annual earnings record has now become the most important document, and the best thought now leans toward the preparation of this record first, as the work sheet so that the original entries become the vital record without the labor and hazard of error incident to transcribing a variety of figures from the payroll. Since the file of individual earnings records must be kept intact as support for various reports to government agencies, it becomes, in effect, a loose leaf payroll with a separate page or card for each employee. The importance of the payroll diminishes as the importance of the individual earnings record increases, until now some companies go so far as to abolish the payroll, as such, entirely, substituting in its place merely a carbon copy of the entries made on the pay checks, and in this form it becomes more in the nature of a pay check register.

Where the individual annual earnings record is prepared first, as the work sheet it usually becomes a quarterly rather than an annual record, so as to provide space for all of the necessary entries. Fig 12 shows such a record as it appears in an organization where the payroll pro-

RECORD OF AUTHORIZED DEDUCTIONS									
SIGN TO		EFFECTIVE WITH PERIOD ENDING _____							
DEPART ENT									
P.ROLL N IT									
PREVIOUS AUTHORIZED TOTALS		DEDUCTION PLANS							
NAME		U S	V I G S	DE TAY C T	CON SOCIAL	REGISTRATION	SAVINGS	HOSPITAL	
		NO 63		1	INSURANCE	DUES			
NAME									
CODE									
NEW AUTHORIZED TOTALS									
POSTED TO RECORD									
INCR INCREASE									
DEC DECREASE									
A ADDITION									
A - MINUS									
Y1 - TRANSFER IN									
T0 - TRANSFER OUT									

FIG 22 Control Record for Authorized Deductions

cedure is quite complex because of bonuses, differentials, carfare allowances, board and lodging allowances, etc. This is presented to illustrate an extreme case, in most instances the record can be much more simple, but this method is the best one where manual methods are followed in a complex situation.

**PREPARING PAYROLL**—Another development retains the original sequence by preparing the payroll first as the work sheet. Economies are made at the other end of the series of operations as follows. Pay checks with accompanying stubs showing details of additions and deductions, are prepared in duplicate, as before, but in this case the duplicates are torn apart and filed in folders, one folder for each employee. This continues for a calendar quarter. Then the quarterly totals are summarized for each employee, using a simple adding or calculating machine, and these totals are entered in spaces provided on the folder which becomes the individual annual earnings record. The duplicate checks are removed to a transfer file, leaving the folders empty for accumulation of the duplicates for the succeeding quarter.

—       —       —       —

Total Pay" for the period, or by consulting precalculated tables where these are practical.

The columns are then totaled and balanced. In most cases, the best method of balancing each deduction column is to start with the grand total of the "Total Pay" column, deduct the total pay for those items not subject to the deduction, and apply the appropriate deduction percentage to the difference. Some tolerance must be allowed for giving and taking fractions of a cent under this method of balancing.

**POSTING EMPLOYEE EARNINGS RECORD**—Where the payroll serves as the work sheet, the individual annual earnings record is posted separately. This may be done some time after the current payroll is completed, but the task must be finished before the next payroll is prepared so as to furnish the cumulative figures needed in computing old age benefit deductions, or, in some cases, state income tax deductions. As before, the figures posted to each column should be drawn off separately on an adding machine and the totals balanced with the corresponding totals shown on the payroll. Where the work of compiling the earnings record is simplified by using carbon copies of the pay checks filed in folders, a tickler file or some other device is needed in the latter part of the year to flag the cut off point where the \$3 000 maximum point is reached for old age benefit and unemployment



insurance contributions and where the starting point is reached in states which require deductions from pay for personal income taxes. Where personnel relations permit it, these difficulties are met by making no change in deductions during the quarter but adjusting the whole matter in the last pay check. While this is obviously the easiest solution mechanically, other considerations make it inadvisable to recommend it.

**NET PAY**—Finally for each employee, deductions from gross pay are totaled and subtracted and the net amount due included. This column should also be added and the calculations balanced in total.

Where several people work on the payroll records each payroll sheet or individual earnings record control card has spaces for fixing responsibility for the various operations, for example

Pay Entered by	Checked by
Deductions Entered by	Checked by
Extended and Footed by	Checked by

**PAYROLL JOURNAL VOUCHER**—Completion of the payroll register makes necessary the preparation of a voucher to summarize the payroll. The exact form of the resulting journal entry depends on the form and number of special columns of the payroll register. For convenience, the discussion is deferred to Section 16 where the entries for the payroll accrual and the distributions are discussed together.

## Payroll Systems

**MANUAL SYSTEMS**—Under a manual system, the payroll, the pay check or envelope, and the individual annual earnings record must normally be prepared separately. Work has been done on the development of boards or devices for holding the three documents in alignment so that they can be prepared simultaneously with the aid of spot carboned forms or carbon paper. (See description later in this Section under "Pegboards")

**BOOKKEEPING MACHINES**—The form of the payroll check or envelope, and earnings record and the methods of preparing them vary widely, depending largely upon the mechanical devices used. These bookkeeping machines are of three types, depending upon their evolutionary origin, viz, those developed from

- 1 Adding machine
- 2 Typewriter
- 3 Cash register

All of these devices are equipped with special form-feeding mechanisms to handle the payroll pay check or envelope and the individual annual earnings record, and when so equipped they are known specifically as "payroll machines." In each of these classes there are a variety of minor subdivisions depending upon the particular make of machine.

An entirely different class of equipment which is used extensively for payroll preparation has evolved from the statistical machine which functions through the use of punched cards. Here, again, minor variations occur depending upon the make of equipment, in general there are two types

- 1 Alphabetic
- 2 Nonalphabetic or numerical



**APPLICATION OF MANUAL PAYROLL ACCOUNTING—**

An excellent manual payroll system designed for use in a plant operating multi shifts is described by Burk (N A C A Bulletin vol 24) The last shift of the week goes off duty Thursday mornings and distribution of pay checks begins Thursday afternoons

Daily time tickets are used A portion of the summary section of each ticket (except Thursday, the first day of the payroll week) is cut away in such a way that when the tickets are superimposed (Fig 23), all daily figures are visible and ready for summarizing Burk states

After checking the summary for accuracy and agreement with the clock card, the totals are transcribed by hand to payroll sheets prepared in advance which already show clock numbers, names rates, and fixed deductions Payroll checks are also prepared in advance on an addressing machine and show clock numbers, names and the date of the close of the work

Federal old age benefit tax and bond deductions are calculated and entered on the payroll at the same time the time ticket summary is entered As each page of the payroll is crossfooted, totaled and balanced the checks are completed checked against the payroll signed, and stuffed in envelopes preparatory to distribution

**Check and Earnings Record**—The pay check (Fig 24) is provided with two stubs in the form of employees' earnings statement The extra stub is detached and retained by the company and is pasted each week to a specially designed quarterly employee's earning record (Fig 25)

(When this stub is folded back the duplicate Employee's Earning Statement on its back is filled out as result of carbon on back of stub below)

---

**BAKER LOCKWOOD MFG CO - FACTORY PAYROLL**  
**EMPLOYEE'S EARNING STATEMENT**

CHECK NO.		NAME						PERIOD EMPLOYED					
1	2	3	4	5	6	7	8	9	10	11	12	13	14

---

**BAKER LOCKWOOD MFG CO. Inc.**  
**FACTORY PAYROLL**

KANSAS CITY MO. \_\_\_\_\_ 194\_\_

PAY TO THE ORDER OF: \_\_\_\_\_ NAME \_\_\_\_\_ IN FULL TO DATE \_\_\_\_\_ AMOUNT \_\_\_\_\_

CL. NO. \_\_\_\_\_ \$ \_\_\_\_\_

\_\_\_\_\_ DOLLARS

TO COMMERCE TRUST COMPANY KANSAS CITY MO. 18-1 BY \_\_\_\_\_

BAKER LOCKWOOD MFG. CO., INC.

FIG 24 Pay Check with Extra Stub for Employees' Earning Record



According to Burk

The cards provide full information on each employee for the current quarter and the year to date without posting. Social security tax returns can be prepared directly from these forms and the data on victory tax withholdings for each employee are readily available from this form.

You will also note that by providing auxiliary columns at the right we were able to accumulate weekly the employee deductions for the purchase of war savings bonds without setting up a separately posted record for each employee.

**PEGBORD SYSTEM**—Methods have been developed and become standard practice for utilizing pegboards and other types of summary boards in summarizing original documents by mounting them in overlapping or shingled fashion so as to expose only the amounts to be summarized. An adaptation of this method to the preparation of payroll documents has been introduced with considerable success in the last few years. The following description of the plan is based on the pegboard system of Felt and Tarrant. Operation of the system applies to the three forms shown in Fig. 26, viz., payroll check, payroll register, and employee's earnings record. In a modification of the plan, the flap of a pay envelope is substituted for the payroll check. As shown by Fig. 26, all related documents are superimposed on the pegboard and overlapped. The forms are designed with standard spacing so that anything written on the top form is automatically reproduced (through carbons) on the related forms in the proper space.

Employee name and number are entered some days before pay day. All the usual data concerning hours, deductions, etc., are posted and net earnings computed. As each payroll check is completed it and the corresponding earnings record card are removed from peg strips, leaving the next payroll check and earnings record card exposed for posting.

After each payroll register sheet is completed it is self-balanced. The grand total of all register sheets within a department is proved against the predetermined departmental total. The following advantages are claimed for this method:

1. **Accuracy**—Since original figures are duplicated through carbons, all three records are in agreement. This eliminates errors in copying from one form to another.
2. **Economy**—No special or elaborate equipment is necessary beyond the pegboard and a calculating machine. Clerical cost is reduced to a minimum.
3. **Speed**—A clerk can easily assemble the forms as illustrated in two minutes or less. The forms may be assembled on extra demountable peg strips in advance so as to be in readiness for payroll closing. The time required to post the payroll depends upon the character of the original payroll data and the number of deductions to be made. There is only one writing and one computation and only one set of totals to balance, hence operations are reduced to a minimum.
4. **Flexibility**—The work may be distributed among any desired number of clerks who can work simultaneously on the production of the payroll. Form design is flexible. Additional classifications can be accommodated without being limited by machine capacity.

**BRANCH AND FIELD OFFICE PAYROLLS**—Where payrolls are prepared in branch offices, it is good practice to set up skeleton payrolls by the use of Addressograph or other duplicating de-



vice at the central office in advance, then mail them to the respective field offices for completion. This establishes a valuable basis for internal check. The payroll, when completed, becomes the basis for replenishing the local imprest fund or payroll bank account.

This method of handling field payrolls is used by a large chain bakery. It operates, besides the central office and bakery, several dozen branches. Employees are paid each week by check. The method is described by Haskell and Robnett (NACA Bulletin, vol 21). Near the beginning of the payroll week, the central office prepares the payroll record for each branch, using an addressing machine with duplicating ribbon. The ending date of the payroll week and the number, name of each employee, and fixed deductions are shown. The records are then sent to the respective branches.

**Branch Preparation of Payroll**—The chief clerk of the branch, with a duplicating pencil, indicates the class of work and department for each employee. Time worked and rate, gross payroll, social security deductions, and net pay are all computed and entered. The clerk then totals and proves the various money columns and then completes and proves the payroll distribution which is shown on the same sheet as the payroll data. The payroll is then mailed back to the central office.

**Completion of Branch Payroll in Central Office**—A numbering machine with duplicating ink is used to enter check numbers on the payroll register. Corrections or changes where necessary are made at this time. The sheet is then placed directly in the duplicating machine and reproduces the data on the following fundamental records:

- 1 Individual earnings record
- 2 Branch copy of payroll sheet
- 3 Cashier's record of disbursements
- 4 Individual payroll checks

The branch copy is a complete copy of the payroll sheet. The cashier's record shows only employee's name and number, check number, week ending, and net amount.

**Use of Duplicator**—In the same organization, earnings records and pay checks are prepared as follows:

The printed forms are purchased in blocks, overlapped to correspond to the number of lines found on the payroll sheet. Only the top line of each form is visible. The forms are held in place by a gummed strip. One direct duplication for each page prepares the earnings record and the check. The forms are then cut from the gummed border, the checks are signed and "protected" by machines and mailed to the branches for distribution. The employees' earnings records are individually filed and summarized quarterly on a file guide.

The above method requires only one writing of the payroll data. The basic record provides all the information necessary for direct preparation of each record or document involved. All proving is done on the original record. From then on each record is an exact duplicate of the original data, avoiding the necessity for further computations or rechecking.

**MECHANICAL INSTALLATIONS**—Most bookkeeping machine systems prepare the basic documents simultaneously. These include the payroll, pay check, and employee earning record. A fourth record is the

employee earning statement which is ordinarily attached to the pay check or if payment is in cash, shown on a separate slip inserted in the pay envelope or on the face of the envelope. Finally, the check register may also be prepared simultaneously with the other forms. Fig 27 shows an illustration in which all five of these records are produced in a single writing. The figures for #4635 Harry E Brown, may be traced on all the documents and records illustrated.

Fig 27 also illustrates a new development in the case of payroll machines. In making payment by check a number of concerns have found that the deductions are so numerous that it is better to employ a coding system for deductions. This permits flexibility and avoids the necessity of using a check stub twice the size of the check as is now the case in some places. This is overcome in Fig 27 by the substitution of vertical listing of deductions on the check stub instead of the more usual horizontal arrangement. Figs 19 and 25 illustrate the common type of horizontal expansion. Fig 27 shows the records prepared on a machine developed by the National Cash Register Company, and shows the economy of space resulting from listing the required information in vertical columns, each figure being suitably coded.

Somewhat similar in operation but not providing a concurrent check register is the system used by the Winchester Repeating Arms Co (Fig 28). The operation of the latter company's system is described in American Business as follows:

The sources for postings to the payroll records are "shop payroll" forms on which are shown hours worked by each employee each day as well as regular and overtime earnings. When all information for a particular pay has been received in the payroll accounting department (usually by Tuesday afternoon) hours and earnings figures appearing on the shop payroll forms are cross footed and balanced by shops. Overtime if any is then added to regular earnings to determine the amount of gross earnings, following which social security and Winchester Fund deductions are entered. War bonds insurance and other deductions are pre posted since they are fixed amounts not dependent upon the amount of earnings as are the social security and Winchester Fund deductions.

When this information has been recorded and balanced, the shop payroll forms go to the posting machine operators for preparation of the payroll records. Winchester's is entirely a check payroll which except for a few executives, is paid on Thursday and Friday of each week.

Prior to this time pay draft registers have been addressed with man's name, social security number, pay date, check number, etc.

First picking up the old balances of amount earned and social security tax the operator enters and prints the current amount earned and current social security tax, the machine automatically computing and printing totals to date for both.

The operator then picks up the old balance of hours worked and enters and prints the current hours with the machine automatically computing and printing the total to date. To complete the records, the operator enters the net pay figure which automatically prints in two places on the check and in one place on the employee's statement and pay draft register. All other deductions are then entered and printed in one operation.

The machine automatically accumulates totals of current gross earnings, current social security tax, amount earned to date, social security tax to date, miscellaneous deductions, insurance, Winchester Fund, amount paid, hours current and hours to date by shops and these totals must agree with the control figures previously set up when the shop payroll forms were



DEPARTMENT		EMPLOYEES		PAY PERIOD FROM JAN 31 19-- TO FEB 6 19--												SHEET NO. 1	
EMPLOYEE	NO.	DATE	TIME	DATE	TIME	DATE	TIME	DATE	TIME	DATE	TIME	DATE	TIME	DATE	TIME	DATE	TIME
4530 272-07-1811	27259	50.00	10.00	8	50.00	10.00	8	50.00	10.00	8	50.00	10.00	8	50.00	10.00	8	50.00
4415 175-04-3375	27560	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00
4602 102-15 3184	27561	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00
4574 184-18-0516	27562	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00
4685 175-12-1415	27563	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00
4685 175-12-1415	27563	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00

DEPARTMENT		EMPLOYEES		PAY PERIOD FROM JAN 31 19-- TO FEB 6 19--												SHEET NO. 1	
EMPLOYEE	NO.	DATE	TIME	DATE	TIME	DATE	TIME	DATE	TIME	DATE	TIME	DATE	TIME	DATE	TIME	DATE	TIME
4530 272-07-1811	27259	50.00	10.00	8	50.00	10.00	8	50.00	10.00	8	50.00	10.00	8	50.00	10.00	8	50.00
4415 175-04-3375	27560	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00
4602 102-15 3184	27561	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00
4574 184-18-0516	27562	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00
4685 175-12-1415	27563	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00
4685 175-12-1415	27563	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00	10.00	8	40.00

Fig 27 Simultaneous Mechanical Preparation of All Related Payroll Records  
(Continued on oppo etc page)



balanced. Possible errors are localized by balancing each shop's records independently and since all related records are written simultaneously absolute agreement between records thus is assured.

**Speeding up Postings**—Early in the operation of its plan, Winchester found that due to inefficient arrangement around the machine of the posting media and the records to be posted, the production rate was suffering. This condition was corrected by placing the records closer to the machine so that the necessary operator arm travel was reduced. To promote sustained high-speed production of the payroll records Winchester operators work in shifts of two hours each then turn the work over to another set of operators who also post uninterruptedly for two hours each, and so on until all records have been posted. Of course, when not posting, all operators have other duties to perform within the department.

A combined manual and mechanical payroll installation is described by French (*American Business*, vol 13). It covers the method used in the Ford Company's River Rouge plant.

The usual procedure is followed by the personnel department in making out an employment card for a new employee, furnishing him with a badge and clock card. The latter has spaces for deductions for punching in and out on fourteen days (the pay period is two weeks), total premium hours, total regular hours, rate, tax, premium, base pay, and gross wages. A perforated pay receipt is attached.

At the end of the pay period, the timekeeping department sends the clock cards to the payroll department where they are audited for lateness, failure to ring extensions, and night work. The cards are then sent to the Addressograph division where they receive the imprint for the badge number, social security number, name, rate and deductions. They are then returned to the payroll department which performs the following manual operations:

- 1 Posts shortages and deductions from previous pay endings
- 2 Posts initiation fees, insurance and union dues that were not deducted on previous pay endings
- 3 Checks rates by matching plate stamp on clock card against clock card number
- 4 Checks all shortages and deductions

Comptometer operators then add the clock card hours. Wages, social security tax, and other deductions are figured by means of Mielicke cards (Fig 14). The wages and tax deductions are then checked by the comptometer operators.

A missing list is also made up by the Addressograph division on all cards not received from the timekeeping department. Cards stamped "No Time" are made up on all clock cards missing from the payroll. The next step is to send the clock cards to the payroll machines where pay envelopes are checked and an adding machine tape is run from the clock cards for wages, social security tax, and other deductions or additions. The payroll machines print four original records in one operation.

- 1 Pay envelope (or pay check)
- 2 Statement of earnings and deductions attached
- 3 Earnings record
- 4 Combination payroll journal and check register

PAY DRAFT REGISTER																																																																											
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DATE	NAME	AMOUNT	DEBIT	CREDIT	BALANCE	DATE	NAME	AMOUNT	DEBIT																																																																		
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Fig 28 Simultaneous Preparation of Employee and Payroll Records

The pay envelopes are checked against the clock cards after which they go to a group of money distribution machines. Here the total pay of each employee for the period is denominated and the totals for each payroll section are accumulated on the machines. A check for the payroll is sent to the bank and the latter sends out the money in the exact denominations ordered. The pay envelopes are then put in boxes with the denomination sheets and sent to the paymaster's office. There, in a special room equipped with automatic coin sorters and counters, men count the money and put it in pay envelopes. All money received from the bank is counted by being run through an automatic coin sorting and counting machine. The exact amount of money required in the proper denominations for each payroll section must be accounted for.

The pay envelopes are placed in trays and loaded in armored pay cars which drive into the plant and pay the workers in the buildings where they are employed.

**TABULATING EQUIPMENT**—Tabulating equipment is valuable for preparing payrolls and related documents, either numerically or alphabetically. Numerical equipment for payroll purposes is now becoming obsolete, because of the necessity for translating clock numbers into employees' names.

Companies like Kelsey Hayes Wheel Company have used punched card installations for some years. The discussion below is based upon the practice followed by another company, manufacturing heavy machinery.

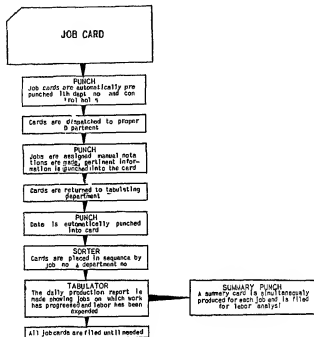
**Records Required**—The system begins with an ordinary weekly clock card. Daily payroll check sheets (Fig. 29) are prepared manually from time tickets or from individual daily time sheets. From these daily sheets, daily earning cards are punched. Separate premium check sheets are prepared daily to show the premium earnings of each worker. Additional earnings cards to cover these premiums are then punched for each worker. At the end of the week separate bonus check sheets are prepared for each employee and another set of earning cards to cover the bonus is punched. Further cards used in the operation of the system are as follows:

- 1 Master name card. This is used for printing the name of a worker on the payroll sheet and on the pay receipt portion of the clock card.
- 2 Master rate card. This is used for the mechanical extension of wage rates in the multiplier.
- 3 Weekly summary earnings card. This is used for accumulating weekly earnings on the tabulator and for calculations of payroll deductions on the multiplier.
- 4 Recurrent master deductions card. This is prepared from a master deduction file to cover insurance, defense bonds, etc. The card is used one week in each month for recurrent deductions.
- 5 Miscellaneous deductions. This is used for miscellaneous payroll deductions which are not recurrent.
- 6 Quarterly summary. This is used for social security and income (wages and salaries) reports to the government.

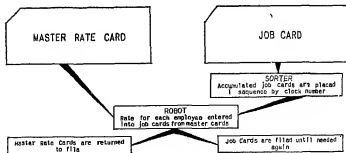
After the cards have been sorted and collated they are then put back in the tabulator for the printing of the payroll (Fig. 30). The com



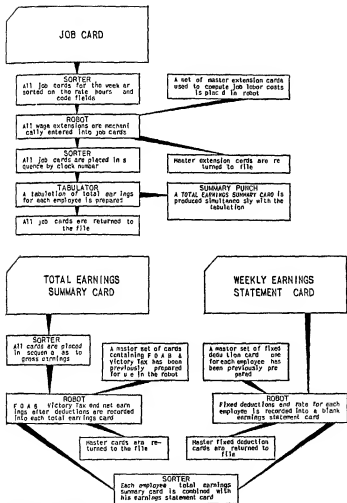
## Daily Operations,



## Semi-Weekly Operations

FIG 31 Punched Card  
(Continued)

Weekly Operations



Payroll Procedure  
on following page)



## Weekly Operations (Continued)

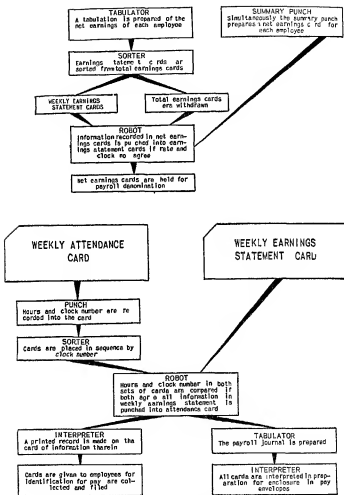


FIG 31 (Continued)

pany pays the workers in cash, using for that purpose a window envelope and enclosing a statement prepared on tabulating machines for use by the employee. It is of course possible to pay by check using punched cards checks if desired. Such checks contain the usual information concerning deductions etc.

Another illustration of a punched card system of payroll accounting is described by MacCauley (NACA Bulletin, vol 24). This system, although employing different punched card equipment from the one described above, eventually accomplishes the same purpose. The payroll procedure is described graphically by MacCauley. The robot referred to in Fig 31 is a special machine handling tabulating cards from two feeding magazines for the following purposes:

- 1 To reproduce from an original set of punched cards, either a duplicate set card for card or many cards from one
- 2 To compare two sets of cards for the purpose of verifying one set and if denied, for sorting cards which match from those which do not
- 3 To compare two sets of punched cards in order to reproduce all or part of the information contained by one set into matching cards of the other, at the same time sorting cards which match from those which do not match

## Payroll Disbursement

**TO WHOM PAYMENT IS MADE**—Except in unusual cases such as the incapacitation or death of the employee, or to comply with legal requirements, salary or wage payments are made only to the employee to whom they are due. Where these payments are to be made to some other person, approval in writing is first obtained from the personnel manager, the legal department, or some other qualified high official of the company.

**ADVANCE PAYMENTS**—Advances of unearned salary or wages should never be made. When authorized advances are made against the portions of salary or wages already earned proper deductions are made for social security, personal income tax, and other required purposes. A separate pay receipt is taken for each pay period involved, and these are held until the respective payrolls are made up, at which time the advance pay receipts are attached to the appropriate payrolls.

Special payments to employees leaving the service may be made for the following reasons:

- 1 Vacation compensation adjustment
- 2 Payment on account of lay off
- 3 Payment in lieu of notice to employee dismissed

Such payments should be properly approved in advance, and full explanation should be noted on the payroll. Payment to an employee leaving the service should never be made until the last day on which actual service is expected.

**PAYMENT IN CASH**—Payment in cash requires some means of safeguarding the funds from the time they leave the bank until they reach the employees. Some form must be provided on which to obtain

the employee's acknowledgment of receipt of the pay. Distribution of the cash into pay envelopes involves considerable work, and if not done carefully errors are bound to occur. The one advantage of this method is that it gives an opportunity to balance the whole cash operation before any cash is handed out.

**Denominating the Payroll**—To fill pay envelopes efficiently it is necessary to have on hand the proper quantities of currency and coins of the various denominations. This is accomplished by the process known as "denominating the payroll." The payroll is provided with ten or more additional columns for the denominations from one cent to twenty dollars (Fig. 32). Sometimes a separate form ruled horizontally to match the payroll rulings, is used for this purpose. The denominations required to pay each item on the payroll are tallied and the columns are totaled and balanced. A check for the total amount is drawn and presented to the bank with a list of the total quantities required of each denomination. It is important to count the cash immediately upon receipt from bank, for two reasons:

- 1 To notify bank immediately in case of any difference
- 2 If not verified and there is a mistake it will not show up until all envelopes have been filled and then a lot of needless detail ensues to prove envelope filling correct and the original amount of cash incorrect.

**Filling Pay Envelopes**—The job of placing proper amounts in each pay envelope is entirely completed to insure against overage or shortage before any envelopes are distributed. If the roll is large each page may be totaled separately and a recapitulation prepared to obtain the grand totals. Then the paymaster can break down the total actual cash in accordance with the page totals preparatory to distributing the cash for each page into the corresponding pay envelopes. This makes it much easier to locate the error within a single page in case of overage or shortage.

**Obtaining Receipts**—When pay envelopes are delivered, the contents is checked by the employee in the presence of the paymaster or other disbursing official. A receipt for the net amount is signed by the recipient and this is used by the paymaster to discharge his responsibility for the cash. Some concerns have a perforated receipt slip attached to the pay envelope for this purpose. Others, in order to save time at the pay window, distribute receipts to employees in advance through their foremen so that the employees may raise any questions and sign their receipts before they reach the pay window. This also serves as additional identification.

**PAYMENT BY CHECK**—Payment of wages by check is gradually supplanting payment by cash in the larger cities, due principally to the hazard involved in handling large sums of money both in transit and on the premises. Since the indorsed check constitutes a receipt no separate document need be prepared for this purpose. Payment by check does not, however, entirely avoid the necessity for safeguarding funds. Some means must be provided for cashing the checks, this is good personnel practice and is mandatory under the laws of some states. If possible, arrangements are made with a nearby bank for cashing

PAYROLL TOTALS AND DENOMINATIONS

PAYROLL ITEM	PA. ROLL DENOMINATIONS										C. ROLL TO ROLL				Week Ended				RMT. OF CH.	
	C. ROLL										C. ROLL TO ROLL				Week Ended				RMT. OF CH.	
	5	10	20	50	100	200	500	1000	2000	5000	DAYS	HOURS	MT. EARN.	GR. P.	C.	UNEMP.	RET. AMT. PD.	RET. AMT. PD.	RET. OF CH.	RET. OF CH.
5	26	220	50	70	56	130	63	181	53	287	792	6231	3336	32	3269	3326	3270	37121	43	43
6	23	95	76	94	32	76	66	101	59	235	506	4042	2163	104	2157	2157	21190	31	81	81
7	28	331	93	79	169	91	143	220	36	388	1151	9020	4862	26	4802	4801	477143	67167		
8	41	301	130	245	103	135	147	225	106	542	1261	10205	5357	19	5316	5356	525047	54227		
10	5	119	32	22	10	69	14	107	12	94	413	3048	1503	92	1504	1504	155424	38	46	46
11	42	204	131	186	102	138	119	233	107	507	1252	8444	5003	74	5011	5004	408617	84161		
TOTAL	21	216	616	1107	718	1000	255	1000	27	348	836	6628	3534	15	3513	3513	3460218	532	1128	1128

FIG 32 Summary of Payroll Totals and Denominations

the checks. In order to facilitate such a procedure the bank is advised that the employees will present identification cards or badges supplied by the company at the time of cashing their checks. If such arrangements cannot be made then the paymaster himself must set up a window for the purpose. This is perhaps worse than payment in cash in the first place, because the funds must be safeguarded over a longer period, congestion at the window when the workmen leave work is harder to avoid, or as an alternative they must be permitted to cash checks on company time. If an error occurs in any transaction there is no means of detecting it until the day's work is balanced, when it is too late to trace or rectify the error. Finally, payment by check involves the task of reconciling the payroll bank account with the check register.

**Payroll Bank Accounts**—Where payment is made by check and the payroll is large enough to justify it, a special payroll bank account is used. This special account, designated "Account No. 2," "Special," or other identifying term, is established and maintained by drawing checks on the regular company account and depositing them in the special account. The latter is used only for salary and wage payments including amounts remitted to institutions to the credit of employees in connection with savings, insurance union dues, and similar payroll deduction plans.

In some cases arrangements may be made to pay the bank a flat fee for its services calculated on the basis of the number of checks handled each pay day. In other cases it is satisfactory to deposit in Account No. 2 the approximate amount of the payroll in round figures two or three days in advance of pay day, so that the use of the money during this period plus the normal float of the pay checks compensates the bank in part for its services in handling the special account. The amount so deposited is normally less than the net amount of the completed payroll. In any case, when the payroll has been completed, the final deposit for the current period is made in an amount sufficient to bring the balance in Account No. 2 up to the exact net amount of the payroll for which checks have been drawn, so that after all checks for the period have been issued the account balances as shown by the check register.

**Check Register**—A separate check register or bank register is maintained for the Payroll Cash account, and is used to account for every check number in the series. Consecutive check numbers of the same date may be entered by groups for example, 601-750, since details as to payee and amount for individual checks appear on the payroll or its equivalent. In some mechanical installations, payroll journal and check register are combined on one form. Any checks spoiled in the course of preparation or voided for any reason before issuance are entered in the check register with appropriate explanation. If a check is canceled and superseded by another, appropriate cross references are made in connection with the entries for both checks. If a check is voided or canceled for any reason the word "canceled" is stamped or written across the face of the check and holes are punched in the signature space, no check is destroyed.

**Form of Payroll Checks**—The checks used for payroll payments are usually of a different color from those used in connection with the

regular account, and the name of the special account e.g., "Account No 2," or Pay Draft Pay Warrant etc., is printed conspicuously. Checks for the weekly payrolls may have a legend such as "Not Good for More Than \$100.00," printed conspicuously across the face of the check. In other respects the payroll checks may be similar in design to the regular checks of the company.

The stock of checks should be kept under lock by a responsible official, and issued to the employee who prepares the checks in blocks of 500 or 1,000 consecutive numbers as necessitated by requirements.

**DAY, TIME AND PLACE FOR PAYMENT**—The day and time of day for paying off depends on the individual set-up, layout of the plant, number of employees, and various other details. The day for paying off should be as soon after the pay period closes as possible, allowing enough time to prepare the payroll without sacrificing accuracy. The time for paying off is so fixed that it does not interfere with the proper, efficient operation of the plant. Workmen have a tendency to let up on pay day, and for this reason the pay hour is important. A stagger method of payment is used by large organizations, that is, different departments are paid off on different days, at different times. This permits an even flow of payroll work, and makes possible the handling and paying of the payroll by a few employees, and payment by one or more paymasters, according to the number of employees.

As to the place of payment, if the number of employees permits it is well to pay from pay booths or pay windows. These should be so located that employees can be paid rapidly, and also that they do not block either road or foot transportation or other company business.

**IDENTIFICATION OF EMPLOYEES**—The simplest method of identifying employees is by employee's badge or check number. There are other methods, depending on the plant layout. If there are not too many employees the paymaster or whoever pays off generally knows the employees, if not by their full names at least by first names, and can check at the same time the employee gives his check number. In small plants with few employees this question does not come up. In this connection it is well to remember that most concerns prohibit assignment that is, transferring of a right to wages by one worker to another.

**DISBURSING OFFICER**—The question of who pays off is an important one more so if payment is in cash than by check, as under certain conditions if this matter is not carefully handled, padding of the payroll is possible. It should be so set up that no manipulating of the pay envelopes is at all possible. The paymaster or paymasters naturally pay off if the organization uses them. This is in conformity with sound principles of internal check. Aside from the fact that it is their duty to handle cash in any event it reduces the number of employees to be bonded. Some accountants, however have suggested rotation of duties to combat the ever present danger of payroll padding. Thus if distribution is normally made by the paymaster's department the routine might be taken over at intervals by the timekeeping department. This method is probably not favored to any great extent. Instead rotation

within the department, that is, of assistant paymasters and even of the clerical functions, can be worked out and made to yield substantial benefits

**LOST PAY CHECKS**—If an employee loses his pay check he makes written request for its replacement, explaining the circumstances fully and stating whether or not it was indorsed. The company is not liable for the amount of an indorsed check which is lost and employees should be cautioned against indorsing checks until they are cashed or deposited. If the lost check is undorsed, the cashier finds out whether the check has not already been returned by the bank and if not, requests the bank to stop payment. Upon receipt of stop-payment confirmation from the bank a new check bearing a new date and number is issued and suitable notations are made on the check register.

**UNCLAIMED WAGES**—If payment is not claimed at the regular time, the pay envelope is returned unopened to someone responsible for seeing that such envelopes are held in a safe place for a reasonable period until claimed by the employee. Sound internal check requires that these envelopes be held by someone who does not handle other company funds; this is usually the paymaster. When the employee eventually claims his pay, particular care should be taken to insure that he is properly identified in order to prevent some other worker under an assumed name from getting the pay envelope. After the lapse of a reasonable period, from 24 hours to one week, envelopes still unclaimed are opened under suitable controls and the cash turned over to the general cashier to be merged with other company funds and deposited in the bank. Unclaimed Wages account is credited and a suitable subsidiary ledger record is set up. If the salary is later claimed, payment is made by voucher and charged to Unclaimed Wages.

If the unclaimed wages are in check form, the cashier indorses the check to himself as cashier as follows:

Pay to the order of John Doe Cashier  
(Signed) John Doe

Below this is written a cross reference to the document which carries the original credit to Accounts Payable—Unclaimed Wages account. The cashier then deposits the check in his Payroll Cash account.

Sometimes unclaimed wages are turned over to a representative of the personnel department, who makes delivery a pretext for the initial call to check on the reason for absence. In such cases signature on the signed receipt turned in by the personnel representative should be carefully verified with the signature on the service record.

When all transactions are completed, as above the net total of the payroll run is the credit to Unclaimed Wages is balanced with the file of signed receipts.

**Unclaimed Wages at Branch Plants**—A well-known industrial company with a head office and many operating subsidiaries has established the following procedure in connection with unclaimed wages:

The unclaimed wages of each plant are temporarily retained at the plant. Semi-annually those remaining unclaimed for more than three months are transferred to the head office, giving rise on the main office books to the following entry:

General Cash	\$
Miscellaneous Accounts Payable—Unclaimed Wages	\$

The head office keeps a subsidiary record of unclaimed wages which shows date credited, name of employee, check number (original check), departmental classification, column for each plant, payroll period (date), amount unclaimed, settlement date and amount (i.e., when unclaimed wages are paid), check number (new check drawn).

Annually, any net credit balance in Miscellaneous Accounts Payable—Unclaimed Wages is closed to Nonoperating Income. The reason for not letting unclaimed wages remain as a liability until the expiration of the statute of limitations is that in the experience of this company, wages not claimed within three months are seldom, if ever, claimed.

After the above transfer is made, claims for unclaimed wages are referred by each plant to the main office. When claims have been verified, a new check is drawn. If the amount involved applies to a prior year, the entry is

Nonoperating Losses	\$	\$
General Cash		

If the amount involved applies to the current year, the entry is

Miscellaneous Accounts Payable—Unclaimed Wages	\$	\$
General Cash		

**AUDITING THE PAYROLL BANK ACCOUNT**—The bank statement for the Payroll Cash account is reconciled or audited regularly by the controller's department or some auditing staff other than the one which prepares the payroll records and checks. Duplicate bank deposit slips, stamped by the bank, pages of the bank register, pages of the completed payrolls, and any voided checks are all forwarded promptly to the controller or auditor. The latter obtains bank statements and paid checks directly from the bank. Upon receipt of the bank statement, the total of the several deposits for each payroll period as shown on the bank statement is checked against the corresponding payroll totals after due allowance is made for deductions retained by the company. Canceled checks from the bank and voided checks from the payroll department are sorted together into one numerical sequence. Missing numbers are listed from information shown on the payroll, and this list of outstanding checks is used in reconciling the balance per bank statement with the balance per bank register (the latter normally being zero). Checks outstanding an undue length of time are followed up with a request that they be cashed.

Detailed spot audits of the Payroll Cash account are made by the controller from time to time, in which he

- 1 Compares the canceled checks with corresponding items on the individual annual earnings record with respect to name of payee and amount
- 2 Makes an examination of indorsements by checking with original signatures on employee's service record
- 3 Determines that payments are made at authorized rates
- 4 Sees that all extensions, computations, and footings are correct
- 5 Insures that duplicate payments are not made



- 6 Checks for proper approval of all allowances for absence
- 7 Determines that deductions are correct and made as required by law or as authorized by the employees

**INTERNAL PAYROLL AUDIT**—The entire problem of safeguarding the integrity of the payroll figures rests in the last analysis on the controller and his internal audit staff. Aside from special payroll audits and investigations, the work can be standardized through the issuance of a payroll audit manual. Brink (Internal Auditing) cites a company that has issued the following instructions in its manual for the guidance of its staff:

#### Salaries, Wages, and Commissions Payable

- 1 Check the balance of salaries and wages payable as of the month end of the period being examined with the detail payroll records. Where the actual represents an amount less than a full payroll make a test check of the calculation of the amount accrued to ascertain that it represents the company's liability for salaries and wages earned as of the month end of the period being examined.
- 2 Have office prepare a list of commissions payable by amounts as of the month end of the period being examined, check footings of list which must agree the total with the balance of commissions payable included in this account.
- 3 Check amounts of commissions payable shown on list referred to in "2" above to commission statements properly approved for payment.
- 4 Select a representative number of commission statements for the period being examined and check rates to commission arrangement contracts and check quantities to sales recapitulation statements.
- 5 Review payroll and attest procedure to see that the company's interests in this connection are properly safeguarded.
- 6 Examine each payroll for the period being examined as follows:
  - a Approvals
  - b See that vouchers drawn therefor are in agreement with totals
  - c Check totals of payrolls to control accounts
- 7 Select one salaried employee's payroll within the period of examination and also the salaried employee's payroll for the month end of the period being examined and examine as follows:
  - a Check rates with payroll records
  - b Check changes in rates additions and terminations with authorizations
  - c Test check overtime
  - d Check totals of deductions to accounts affected
  - e Check footings and extensions
  - f Test check individual deductions in respect of group life insurance
  - g Test check social security deductions
- 8 Select one wage earner's payroll for the period being examined and follow same procedure as in item 7 except that all operations should be carried out on a test check basis.
- 9 If practical for the auditor to obtain bank statements and canceled checks direct from banks for preparation of reconciliations of payroll bank accounts as of the month end of the period under examination, the auditor should do so in accordance with the procedure for bank account reconciliations prescribed in Account. If impractical for the auditor to obtain the bank statements and canceled checks as mentioned then the auditor should check the reconciliations of bank accounts prepared by the office for the month end of the period being examined in accordance with

instructions prescribed for reconciliation of bank accounts in Account Where it is the practice in an office not to prepare payroll bank account reconciliations as of the month end but instead to do so from bank statements and canceled checks received from banks in the subsequent month in order that outstanding checks are reduced to a minimum the reconciliation examination should be effected as of such date and the auditor need not insist on a reconciliation as of the month end of the period of examination It is especially important while making this examination that a liberal test check be made of indorsements and second indorsements on the canceled checks The balances shown on the bank statements may be accepted by the auditor thus making it unnecessary to confirm such balances by direct correspondence with the banks

10 Make liberal test check of rates recorded on payrolls during the period of examination, with authorizations



# SECTION 16

## LABOR COSTS

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## SECTION 16

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# LABOR COSTS

### Definitions and Classifications

**DIRECT LABOR DEFINED**—For cost accounting and control purposes, it is necessary to differentiate between direct and indirect labor. The general rule is that direct labor is labor spent in actual production of the product i.e., labor immediately identifiable with product costs. According to Van Sickle (Cost Accounting),

For a work man's wage to be classified as direct labor, it must be possible to measure the cost applicable to each unit of product or job manufactured. If the labor cost cannot be identified with some particular production cost order number or if it cannot be identified with some productive operation, then it cannot be classified as direct labor.

The above statement may be further clarified by extending direct labor to include labor identified with a process, such as melting, dyeing, galvanizing, etc. Where more than one product is worked on such process labor is only indirectly identified with the product through the application of a process cost or other method of proration.

The American Management Association (A.M.A. Special Paper 10) defines direct labor as

That portion of labor which enters directly into and forms part of the product in contradistinction to subsidiary work also necessary for production.

In connection with government war contracts, direct labor is defined as follows (Treasury Decision 5000 Sec. 269)

Productive labor usually termed "shop labor" which is performed on and is properly chargeable directly to the article manufactured or constructed pursuant to the contract or subcontract but which ordinarily does not include direct engineering labor.

This is further explained in a special government bulletin (Explanation of Principles for Determination of Costs Under Government Contracts)

Direct labor cost consists of wages paid for labor performed on and properly chargeable directly to the article manufactured. Such wages should be taken at the individual hourly rates actually paid on, if a piece-

work or other incentive plan of wage payment is customarily followed by the contractor at such incentive rates actually paid. Special premiums, bonuses, and overtime payments if treated as direct labor costs, should be separately stated. Furthermore, if direct labor cost is the basis of overhead apportionment, such special premiums, bonuses, and overtime payments should not be included in the base for the distribution of overhead.

Direct labor may also include compensation insurance and old age benefit and social security taxes pertaining to such employment.

It is recognized that complete uniformity in the definition of direct labor does not exist even within single industries and that therefore certain operations may be included by one contractor under direct labor and by another under indirect labor. This difference is not material for the purpose of ascertaining cost under a particular contract as a contractor's practice will be acceptable if it is in accordance with sound accounting procedure, and if it is uniform throughout his own activities.

**INDIRECT LABOR DEFINED**—Indirect labor represents auxiliary work done in connection with product manufacture. It is labor that is not engaged in changing the form of the product but which performs essential services. According to Ostlund (N. A. C. A. Bulletin vol. 5),

Indirect labor becomes all that labor in a factory which is not physically applied directly to the product. This includes superintendents, foremen, clerical assistants, sweepers in productive departments and all help of whatever sort in the auxiliary or service departments.

**Classes of Indirect Labor**—Indirect labor may be broadly classified as

- 1 Departmental overhead
- 2 General factory overhead

Some indirect workers spend all their time in one department. Their wages are charged directly to that department and do not require proration among departments. This cost is a part of direct departmental overhead. Examples are departmental foremen, assistant foremen or gang bosses, timekeepers and other departmental clerks (where they work in only one department), departmental tool setters, machine adjusters and inspectors, etc.

Other classes of indirect workers have duties which take them into several departments, or their work is for the benefit of a number of departments. Hence their pay is prorated to the departments served. This cost is a part of the general factory overhead. Examples are general manager, factory superintendent, general foremen, rate clerks in factory office, time study department, schedule clerks, route clerks, chief inspector, etc.

In lieu of direct proration, general indirect labor may be accumulated in a general service account and charged out at a standard service rate. This is especially the case in some of the standard cost systems.

**Standing Expense Orders and Codes**—To each subdivision of indirect labor a standing expense order number is assigned. Thus the indirect labor classification might be as follows:

**Chart of Expense Numbers**  
(To be added as suffix to department numbers)

**PAYROLL CHARGES (Nos 1 through 50)**

- 01 Supervision (Salaried)
- 02 Supervision (Hourly)
- 03 Clerical
- 04 Sweeping and Cleaning
- 05 Watchmen and Guards
- 06 Inspection
- 07 Reworking
- 08 Set ups
- 09 Lost Time
- 10 Repairs to Machinery
- 11 Repairs to Buildings
- 12 Experimental
- 13 Hoisting and Loading
- 14 Handling Production Materials
- 15 Overtime Premiums
- 16 Training
- (Others as required)

By combining department and indirect labor code numbers a complete means of identification is provided

**MANAGEMENT'S INTEREST IN LABOR COSTS**—The specific reasons for management's interest in labor costs are

- 1 To use direct labor cost as a basis for control
- 2 To identify direct labor cost with product cost by attaching the former to jobs processes etc
- 3 To use direct labor as a basis for overhead application where desired
- 4 To determine indirect labor cost as an element in control of efficiency of departments or cost centers

The various administrative divisions of a plant naturally place varying emphasis on these points. Thus the **top executives** may be primarily interested in the ratio of labor costs to total costs in the changes taking place in this ratio, and their effect on the financial statements. The major operating executives, such as the vice-president in charge of manufacturing, plant superintendents, etc. may require additional detail to disclose costs by jobs, processes, operations, departments, etc. **Production control men** and **shop foremen** need detailed figures applying to their particular jurisdictions and giving information as to how each figure compares against some budgetary or other standard.

Interest in labor costs has been sharpened because of the conversion from a peacetime to a war economy. Special problems have arisen in connection with overtime wage payments, night shift premiums and multi-shifts also in connection with cost of training old and new personnel in new skills.

**Applying Direct Labor to Product**—The basic objective in cost accounting for labor is to determine what value the business received for money paid out in the form of payrolls. In the case of direct labor this is accomplished by identifying such labor with product costs during the process of manufacture and upon completion. Initial and inter



mediate steps are to charge direct labor costs to jobs or special orders, classes or groups of products, departments, processes or operations. This objective is universal irrespective of the method of wage payment, whether time or day rates measured daywork piece rates premium rates, or bonus rates, or some other form of incentive system.

**Basis for Control**—Adequate control of labor costs involves more than the reduction of labor expense. It involves verification of the efficiency of labor operations and includes

- 1 Adequate compensation levels
- 2 Product quality in accordance with predetermined standards
- 3 Volume of production in keeping with attainable standards

All of this involves production budgeting, production planning scheduling, routing, dispatching, in brief, production control, and finally comparison of actual labor costs with standard costs to get variances which are analyzed as to causal factors. Even the best job recording time equipment does not insure efficient use of time by employees or effective labor control. The best control is achieved by the use and enforcement of a standard of performance and the determination and follow up of the reasons for variances from the standard. Job recording time equipment is frequently a valuable aid to accuracy in time reporting but there are also many situations in which adequate labor control can be obtained without the use of mechanical equipment.

**Overhead and Direct Labor Cost**—Another objective of management is to obtain direct labor cost for use as a basis for the application of burden to products. Both hours and dollar amounts of direct labor may be used as a burden basis. In some cases, direct labor becomes part of a machine rate, the direct labor and the machine burden being combined to obtain a total machine hour rate. This condition also exists in the case of the sold hour rate in the printing industry, where direct labor cost is an element in the departmental overhead rate.

**Indirect Labor Cost**—Classification and analysis of payroll data yields information concerning the extent and distribution of this item of manufacturing overhead. By comparison with standard costs or flexible budgets, the efficiency of this type of labor may be watched, guided, and controlled.

**IMPORTANCE OF CLASSIFICATION OF DIRECT AND INDIRECT LABOR COSTS**—Proper segregation and definition in the accounts of direct labor costs is important because manufacturing overhead is more commonly applied on a basis of direct labor cost, and direct labor hours, either actual or standard, than on any other basis. Unless the distinction between direct and indirect labor is clearly made and consistently followed, serious errors result in the allocation of overhead. Thus, under a job order method of costing, failure to treat direct labor as such not only reduces labor cost on which overhead is to be applied, but increases the total overhead to be applied on the basis of such direct labor costs. According to Sanders (Proceedings of International Congress on Accounting, 1929), it is not always easy to make the separation and even within the same industry different companies are frequently found following different practices. Hence, it is

desirable in the individual company and also in the development of uniform accounting manuals for industry groups to define carefully those labor operations to be treated as direct cost and those operations to be included in manufacturing overhead for application over all production through the use of overhead rates.

The following illustration of how this may be done is taken from the Manual for a Uniform Cost and Estimating System for the Gray Iron Foundry Industry and relates to labor classification in the molding departments.

**Molding Direct Labor**—Molders apprentices, molder helpers and any other labor in the molding department that can be allocated to individual jobs such as tanning, finishing, core setting etc. Pouring time should be considered as direct labor in shops and departments where the molders pour their own work as indirect labor when pouring is done by a pouring gang.

**Indirect Labor**—All other labor in the molding department, such as

- 1 Transporting molten iron fuel sand, castings patterns flasks, boards bands supplies etc. cranesmen pouring if done by a separate pouring gang, preparing molding sand, moving facing sand, shifting weights, shiling out molds, breaking gates, cleaning up floors, tending mold ovens, gangway helpers whose time cannot be allocated to specific jobs etc.
- 2 Pattern and flask labor not chargeable to customer
- 3 Repair labor such as repairs to equipment in molding department
- 4 Foremen and clerks

The analysis of payroll expenditures and the determination of accurate and usable labor costs depend upon adequate departmentalization of accounts as much as upon any other single factor.

**TEST OF DIRECT LABOR**—The distinction between direct and indirect labor is sometimes difficult to establish. Where fully automatic machinery is used, the worker becomes in effect a machine tender. The machine alters the size or shape of the product while the worker merely feeds the machine at intervals and makes minor adjustments. For example, the question might be raised whether a worker at a modern loom in a textile plant is a weaver (direct labor), a machine adjuster (direct labor), or a repair man (indirect labor).

Modern production technique has forced a reconsideration of what constitutes direct labor. It is clear that if a man is tending a productive machine his labor is as direct as the labor of one producing goods manually. Frequently trade terminology may influence the classification. In the above example the worker may be a weaver or a machine tender according to trade terminology and in both cases be direct labor, but if he is a repair man or set up man he may be classified as indirect labor.

Dohi, Ingraham and Love (Cost Accounting) point out that there are two considerations involved in distinguishing between direct and indirect labor.

First there is the question of identification. In addition there is the consideration of convenience. All costs which cannot be conveniently identified with specific units of products are classified as indirect costs.

In other words the test is the same as in the case of materials: can cost be readily and economically applied to a specific product, job or process? Thus although an item can be identified as direct or as indirect labor in the last analysis the method of charging is a matter for decision of the chief accounting officer or definition in a uniform trade association cost manual.

**BORDERLINE CASES**—A labor item may be direct in nature, but for practical reasons may not be charged directly to a given product, being prorated as direct labor over several products or even treated as indirect labor. Instances of such borderline cases are:

- 1 Spray painting
- 2 Inspection
- 3 Short operations

**Spray Painting**—In paint departments, some painting work such as spraying, is easily identified with, and charged to, specific jobs as direct labor. In other cases, such painting may be done at one time on parts for several jobs. To charge such labor directly to the various jobs entails too much clerical detail. Hence, such labor is distributed on some equitable basis.

**Inspection Labor**—Practices differ among companies with regard to where inspection takes place, the frequency or thoroughness with which it is performed, and how the inspection wages are charged. The work may be performed in the production line or away from the producing unit or machines in locations equipped with special devices. Because inspection is costly it should be confined to the minimum occasions necessary to prevent unsatisfactory products from passing unnoticed. Thus, in a company manufacturing electrical supplies, inspectors were used after every operation for ten operations, but investigation proved that considerable money could be saved by eliminating all but final inspection and permitting the products to be completed before rejecting the defective units. Such a situation occurs, of course, only where material and labor operations are cheaper than the cost of inspection. Of course the ultimate use of a part may be so vital that every piece must be inspected regardless of the relation between inspection cost and material and labor cost up to the point of inspection.

Labor cost of inspection whether in the form of examining or testing, may be considered direct labor or indirect labor depending on circumstances. It is often considered direct labor in cases where each unit must be tested or measured to ascertain if the product is in accordance with predetermined specifications and within tolerance limits established by the engineering department. Employees doing this type of inspection may be engaged on such work for hours or continuously. Thus one drug manufacturer considers inspectors' wages a direct charge or cost of manufacturing, the product inasmuch as in this industry it is necessary to test every item produced to guard against error.

Another type of inspection is **intermittent** or selective for some of the operations or processes. Inspectors in a department make the rounds of the machines, inspecting one or more units of product in a given lot or batch of work, and inspecting enough units to be satisfied that the product is up to standard. This type of inspection is often charged as indirect labor.

If an inspector divides his time between two or more departments, his wages can be prorated over the departments served. Thus the wages of the chief inspector can be prorated to departments on the basis of the number of inspectors in each department.

A third type of inspection sometimes called **sorting or examining** exists where units of product are small in size. When a departmental inspector finds defective or spoiled work at a machine he condemns or rejects temporarily the entire batch of work at the machine by placing a warning ticket in the batch. This prevents further operation on the product condemned until the entire lot, unit by unit, has been examined. Periodically such product is moved to a workplace where each unit is examined. The purpose of such examination is to discover which units are scrap which are spoiled or defective work, and which are good work. The good units are moved to the machine which is to perform the next operation in regular sequence. The spoiled or defective units which can be repaired or salvaged are moved to the machines or work benches where repairs are to be made (See Section 14 for detailed discussion of Scrap, Spoilage, Defective Work, etc.) The wages for this type of inspection are ordinarily treated as indirect labor and charged to the appropriate departmental **standing expense order**. However if the inspectors examine products which have come from several or all operating departments the wages are treated as **general factory overhead**. These are usually prorated to departments with other elements of general factory overhead or preferably charged back to the departments which have caused the bad work.

**Short Operations**—Certain operations require a relatively small amount of time to complete, examples are buffing, scouring and polishing. These are technically called "short operations." Generally speaking, short operations are those which take less than the unit time employed in labor accounting. For example, if the timekeeping rule in a given plant is that only operations which consume 15 minutes or more are recorded on time tickets, then operations which take less than 15 minutes are short operations. They can be recorded either as indirect labor and thus become a part of burden, or as direct labor. As an illustration, case hardening of taps may be handled through the short operations technique, particularly where this operation is carried on within a department chiefly related to other work. Many sizes of taps are handled together and each size is often on a separate order. To separate the actual time taken on each size and order is impracticable. Therefore all case hardening time is charged to a code order or account called "Hardening." It may be considered necessary, however, to record on cost sheets the cost of hardening each of the various sizes of taps. These costs are estimated as follows: the cost of hardening each size is determined by means of test runs the results of which are plotted on a chart. From a curve drawn through these plotting positions or points the approximate cost of hardening intermediate sizes is read. The standard or estimated costs thus derived are charged on all cost sheets and the Hardening account is credited for the total so charged.

The total of the standard costs entered on cost sheets during a given period should approximate the total amounts charged against Hardening during this period. If a difference between charges and credits to

Hardening results, it may indicate that the standard costs should be revised or it may indicate ineffectiveness in the performance of an operation. The current difference in the Hardening account may be closed to Profit and Loss, or it may be included with other expenses in the departmental overhead, or otherwise disposed of.

## Timekeeping for Cost Purposes

**PURPOSE OF TIMEKEEPING**—Timekeeping has two distinct aims

- 1 For payroll accumulation (See Section 15)
- 2 For payroll distribution and labor cost determination

For cost purposes a job record or work report is used as the basis for accounting distribution of the payroll. The prime functions of this phase of timekeeping are

- 1 To know the work done
- 2 To know the cost of the work done

In other words, the job record or work report supplies details from which the cost of labor is applied to the product through jobs or special orders, departments, processes, operations, etc., also to obtain data for applying burden where the basis of the application is time, such as labor hour or machine hour rates, etc.

**WHERE AND BY WHOM TIME IS KEPT**—The source of all labor classification entries is either a time ticket specifying the number of hours or pieces, or both, or a mechanical printing elapsed-time clock which automatically stamps on a specially prepared timekeeping record the elapsed time in hours and minutes spent on a particular operation or unit.

The time of workers in a shop may be kept by themselves, by their foremen by a traveling timekeeper, or by a stationary timekeeper. No universal rule can be laid down as to who should keep time since individual circumstances govern the problem.

A traveling timekeeper is one who moves around the department more or less continuously during the day, noting changes in jobs on the part of workers, and the respective start and stop times.

A stationary timekeeper, on the other hand, has a definite workplace and the employees go to his desk to report start and stop times, changes in jobs and transfers to other departments. A stationary timekeeper should make the rounds of the machines in the morning as soon as the whistle blows, after lunch and several other times in the course of the day, to be sure that workers have not changed jobs without reporting to him. During most of the day he is at his workplace.

**TIMEKEEPING DEPARTMENT**—In most concerns timekeeping is handled by a regular timekeeping department, which represents a separate unit. This is the best procedure when there is a large number of employees, or in a plant with many products and with a considerable variety of operations or classes of labor.

**Responsibility for Timekeeping**—Because of the close relationship of timekeeping to cost accounting, the chief accounting officer, whether his title be controller, auditor, or accountant, has a definite responsibility as regards timekeeping methods and results. On the other hand, the factory superintendent or plant manager, and his foremen, have a responsibility to know the performance of their department and their men and to keep in touch with the situation to see that proper accounting is made for all labor under their supervision. This dual responsibility of

<b>OPERATION TIME CARD</b>				
ORDER No. <u>A 4280</u>		OPN No. <u>792</u>		✓ FINAL
OPERATION <u>Drilling clevis</u>				
PART No. <u>2563</u>				
PIECES	STARTED <u>8000</u>			
	DEFECTIVE <u>67</u>			
	FINISHED <u>7933</u>			
INSPECTED BY _____				
CLOCK No. <u>128</u>		MACH No. <u>37</u>		
TIME <u>207</u>		RATE <u>60</u>		AMT <u>12 42</u>
PCS FIN <u>7933</u>		RATE <u>001</u>		AMT <u>7 93</u>
				GAIN _____
				LOSS <u>4 49</u>
FOREMAN O K	DESCRIPTION	STOP		
OK CUL		START		
		STOP	<u>80</u>	<u>W 8 0</u>
	<u>same</u>	START		<u>W 0 0</u>
OK CUL		STOP	<u>45</u>	<u>TU 4 5</u>
	<u>same</u>	START		<u>TU 0 0</u>
OK CUL	<u>Tool # 1473 A</u>	STOP	<u>82</u>	<u>M 8 2</u>
		START		<u>M 0 0</u>
<b>TOTAL</b>			<u>207</u>	

FIG 1 Job Order Time Ticket

both accounting and production officials leads to two types of timekeeping organization

- 1 Timekeeping function may be entirely under direction of the chief accounting officer's organization
- 2 Time clerks may be under the supervision of the plant manager

Where timekeeping is a function of the accounting organization, it is sometimes required that the foreman initial all tickets (Fig 1). This recognizes the foreman's interest in the results. Care should be taken in such cases however to insure that these reports are really examined, and not casually signed.

Where time clerks are under supervision of the plant manager, the chief accounting officer should retain responsibility for specifying methods and procedures and for auditing the results from time to time. The expression is often heard, "We do not want to make clerks out of our foremen." It should be recognized that the foreman's chief interest should be in production and that he should not be compelled to neglect supervision of production matters in order to keep or supervise details of timekeeping.

The best arrangement under typical conditions in a large organization is to establish a regular timekeeping department with time clerks responsible to a head timekeeper or supervisor. The latter in turn is under disciplinary supervision of the plant manager. However, procedures are specified and spot-checked by the controller or other accounting officer through his works accountant or cost department.

**DUTIES OF TIMEKEEPER**—Timekeepers often have a variety of duties connected with their jobs, in fact they are frequently overburdened with miscellaneous duties that should be performed by a factory clerk. It is therefore necessary to reduce their duties to written standard practice instructions. In general, a timekeeper's responsibility covers four types of activity:

- 1 Duties in connection with handling of time cards in the shop
- 2 Duties in connection with the preparation of time tickets for the payroll department
- 3 Duties in connection with production reporting
- 4 Duties in connection with production planning

In one plant the daily time cards, after being collected at the clock stations, are first taken to the desks of dispatch clerks. These clerks route and schedule jobs, check the individual start and stop times of jobs, and supply workers with requisite materials and tools needed for the various jobs to which they are assigned. An illustration of a timekeeping function, combining all of the elements mentioned above, is described by Taylor (N.A.C.A. Bulletin, vol 18). The timekeepers are responsible to the cost department and their duties outlined as follows:

- 1 To prepare daily time tickets for each man for each operation. The time tickets in this case show:
  - a Employee's clock number and name
  - b Operation name and number
  - c Part name and number
  - d Order number
  - e Account number
  - f Start and stop times of job and elapsed time

- g Rate paid
- h Total earnings on the job
- 2 To check the correctness of each item on the time ticket, except the rate and total earnings
- 3 To post quantities completed by operations and clock numbers on each order
- 4 To send completed order to the payroll department as notice of its completion
- 5 To turn over each day's time tickets to the payroll department the next morning after posting the necessary time to the shop order summaries
- 6 To maintain a cumulative record of the quantities on each order by operations
- 7 In some departments also to maintain certain stock records and make out various statistical reports
- 8 Obtain foreman's approval on job tickets
- 9 During inventory taking to make out the inventory tickets

**LOCATION OF TIMEKEEPERS**—This question can be answered only in a general way—they should be located as near as possible to the center of their operations

Taylor states (NACA Bulletin, vol 18)

or two

**RELATION OF TIMEKEEPING, COST ACCOUNTING, AND PAYROLL PREPARATION**—The desirability of reconciling cost records with the general books is now generally recognized. Such reconciliation insures greater accuracy and completeness of the cost records. It also provides valuable internal check on payroll payments. Batches of time tickets cannot be left out of labor costs if these must balance in total with the payroll details. The payroll cannot easily be padded or falsified if the manipulation must be balanced by corresponding manipulation of detailed cost figures which in turn must be reconciled with inventories of goods produced.

Fig 2, adapted from Bangs (Factory Management) illustrates in the form of a flow chart the relation between timekeeping and payroll accounting and labor costs. The illustration covers the sequence of steps for one direct worker and one indirect worker (trucker). Dispatching and attendance are part of the functions of a timekeeping department; the latter feeds its data into the payroll department where the attendance





records (clock cards) and the work records (job time cards) are compared. The completed payroll in turn forms the basis for charges to cost controlling accounts while detailed labor cost distributions are posted directly from the job time cards by the cost department.

**TYPES AND FORMS OF TIME TICKETS**—For the purpose of labor cost accumulation and production control, many forms of time tickets are used. In continuous process production, it is possible to combine the payroll record with the time ticket since the worker in all likelihood is doing the same work continuously. In general however, the following conditions may prevail, covering the issuance of time tickets:

- 1 A single ticket issued covering an entire payroll period. Sometimes one ticket may be issued for an entire job with the proviso that if the job is not finished by the end of the payroll period the ticket must be turned in at that time and a new one obtained.
- 2 A new ticket issued each day. If more than one job is worked on in the course of a day the distribution of the time to each job is indicated on that ticket.
- 3 Separate tickets issued for each job worked on each day.
- 4 Time sheets used as a basis for preparing punched tabulating cards.
- 5 Group or gang sheets to keep time for a group of workers.

**Single Ticket for a Payroll Period**—The use of a single ticket for an entire payroll period is advisable only in those cases where a worker is doing the same work regularly. It is, therefore, not advisable in the case of job order industries. Where this system is used, however, a separate payroll procedure must be developed, since payroll and labor cost procedures are independent functions.

A variation of the above scheme consists of issuing a separate ticket for each order (Fig 1). The operator keeps the ticket until the order is completed. Fig 1 shows completion of the work on Wednesday. Hence the word "Final" is checked. All tickets must be turned in whether the job is completed or not at the end of the payroll period so that the resulting labor costs may be checked against the payroll records.

**Single Ticket for Each Day**—Where a single ticket is used to show labor distribution in the course of a day, it is so designed that it shows the operation or order number, the starting and ending time, the elapsed time, the rate and the labor cost (Fig 3). The advantage of this system is that the labor distribution can be checked independently each day against the payroll accumulation.

Fig 4 also represents a combination clock card and job time ticket. It has the added advantage of showing the clock record on the same form as the labor distribution, making comparison and reconciliation easier. However any instructions concerning the work to be done must be shown on a separate form.

**Unit Tickets**—Fig 5 shows a form of time ticket representing a high degree of flexibility. A separate ticket sometimes called a unit ticket is issued for each job each day. Thus a worker turns in during the day as many tickets as there were jobs worked on. The ticket in question contains all information necessary for payroll as well as labor cost calculations. Much of the information is preprinted. The employee's number

NAME	NO	DATE
Henry Soudt	45	MAY 6 1944

OPERATION OR ORDER NO	COST	DATE	ELA. SUP. VALUE	CLOCK RECORD
		5		8
		5		8
		5		8
		5		8
		5		8
		5		8
		5		8
		5		8
		5		8
3799	54	60	9	M9 5 M8 6
3796	42	60	7	M8 6 M7 9
3784	108	60	18	M7 8 M6 0
3772	144	60	24	M5 5 M3 1
3761	126	60	21	M3 1 M1 0
Total Cost	474			

Fig 3 Daily Time Ticket Showing Job Distribution

DAILY TIME CARD									
NO 87		DATE 5/1/44							
NAME Joe Clinton									
JOB		8 30		CLOCK RECORD					
5	4782	IN	11	10	1944 MAY 1	9 54			
		OUT	12	10	1944 MAY 1	8 30			
5	4746	IN	11	47	1944 MAY 1	10 41			
		OUT	12	47	1944 MAY 1	9 54			
5	4103	IN	11	12	1944 MAY 1	11 53			
		OUT	12	12	1944 MAY 1	10 41			
5	4307	IN	11	11	1944 MAY 1	1 50			
		OUT	12	11	1944 MAY 1	12 30			
5	4112	IN	11	34	1944 MAY 1	2 25			
		OUT	12	34	1944 MAY 1	1 51			
5	4122	IN	11	41	1944 MAY 1	3 30			
		OUT	12	41	1944 MAY 1	2 25			
5	4130	IN	11	16	1944 MAY 1	4 29			
		OUT	12	19	1944 MAY 1	3 10			
		IN	ON						
		OUT							
		IN	11						
		OUT	12						
		IN	11						
		OUT	12						
IN	OUT	I	O	N	OUT	TOT			
8 27	12 04	12 27	4 35			7 21			
						7 12			

FIG 4 Combined Clock Card and Job Time Ticket

and name are imprinted from an Addressograph stencil. The time issued and returned is stamped on an electric clock. The bottom portion as to quantity and hours is filled in by the timekeeper, rates and extensions by the pavilion department.

**Daily Time Sheets**—Where tabulating equipment is used, unit labor cost tickets may be automatically produced. One manufacturer of heavy duty machines employs a combination manual record and punch card system for obtaining labor costs. Fig 6 shows the manual record. A separate sheet is made out for each worker each day by a unit system checker or time clerk who fills out the basic information from which the necessary computations are made in the cost department.

- 2 In the case of direct labor, the production number is put in the proper space, in the case of indirect labor, the standing order number

3 Number of pieces on the order and pieces finished. The computations are as follows. The production standard of 380 represents the number of minutes required per unit, therefore,  $2\frac{1}{2}$  multiplied by the production standard yields 897 production units. Similarly, the production units for the indirect labor are added (including in this case a time allowance of 15) giving a total of 892 units. The standard units for ten hours (nine hours productive, one nonproductive) amount to 600, therefore there are 292 premium units. The premium shown is approxi-

<b>DK7F</b>									
EMPLOYEE NO AND NAME									
RETURNED					CHARGE TO <b>DK7Fin</b>				
ISSUED					SHOP <b>DK7F</b>				
ARTICLE		PART		<b>PRIME</b>		LOT No			
OPER NO		OF SYMBOL				MACH SYMBOL		IPPH	
INSTRUCTIONS									
<b>DAY WORK</b>									
GROSS QUANT TO DO									
QUANTITY TO DO	QUANTITY FINISHED	MACHINE HOURS	OPERATION HOUR	RATES			OPERATION COST	MACHINE COST	
				PIECE	MIN	CH	HOUR		

FIG 5 Unit Labor Cost Ticket

tioned over the jobs worked on for the day. Under the plan used by the company, the premium amount is \$4.00 of which 9/10 is charged to productive work, 1/10 to nonproductive work.

On the extreme right-hand side of Fig 6 is the operator's voucher which is detached and handed to the operator as soon as the necessary figures have been computed. The first figure 89, is called "unit hour," but is in reality an effectiveness index. It shows the relative speed of the operator when matched against the standard for the given work. It is computed by dividing the total points (892) by the number of hours (10). It is thus an element in the control of labor costs.

From each daily time sheet in the same plant a punched card is prepared for each job shown thereon. In the illustration shown, one direct labor and one indirect labor card are punched. These punched cards represent the labor distributions. A variation of the above scheme consists of issuing a source card which then becomes a payroll card (Fig 7). For each change of work shown on the payroll card a separate labor cost distribution card is punched.

The payroll and distribution cards are then sorted by clock numbers together with a set of master rate cards which contain the clock number and hourly rate of each worker. Rates are automatically punched on each worker's payroll cards and distribution cards.











In the tabulating department, an automatic reproducing punch transfers the information on the master rate card to the tabulating card. The master cards are then returned to the timekeeper to be used again. Manual punching is used to record quantity, actual hours, and either day- or piecework. A multiplying machine then extends the cards to show total actual earned time. However, only those cards where the standard is different from the actual time need to be extended to get the standard time and the variance. In this way multiplying time is out in half, and the number of cards which otherwise must be analyzed for labor variation is reduced by 90%. The resulting variations are then analyzed as to causes.

**CHECKING TIME CARDS**—At the end of a shift when the cards have been rung out by employees, they are forwarded to the payroll department. If payment is made strictly on the basis of time worked, the timekeeper's detailed time tickets for operations performed by each individual employee are reconciled each day with the in-and-out clock card, or other attendance record. Any difference in time is investigated at once and charged to some such departmental expense account as "Lost Time," if it is found not to be chargeable to production. Thus total productive hours plus lost time reported for cost accounting purposes balance with total hours reported for payroll purposes. At the time of this reconciliation, the hourly rate may be posted to the time tickets preparatory to computing job labor costs. (For short-cut methods of reconciling payroll records with job cost records, see discussion later in this Section.)

If payment is made on a piecework or bonus basis the timekeeper's detailed tickets constitute a basis for calculating pay. The pertinent data should be either posted each day to the in-and-out clock card, or other attendance record, or at least checked against it.

When the actual hours on the daily time cards are checked by the payroll department against the time clock markings on these cards, the propriety of job charges on the cards is reviewed. This is especially the case on government contracts where the resident cost inspector may have considered some items as inadmissible or partially inadmissible.

**DISPOSITION OF TIME TICKETS**—The time or piecework tickets, after reconciliation with payroll data, are turned over to the cost department. All such tickets are posted to their proper shop orders through some form of columnar distribution sheet or by means of some other suitable distribution medium, in order to determine the exact labor costs on each individual work order. In many organizations, these tickets also show machine hours (Fig. 5) which are likewise posted to the proper shop orders. Some or all of the overhead may be applied to the product on the basis of machine hours or as a percentage of direct labor. The use of distribution media cuts down the volume of postings to job order or process cost sheets by accumulating subtotals of labor costs. In punched card installations such sorting can, of course, be produced easily. Another effective and inexpensive method of quick sorting is through the use of Key-sort equipment. The grooving to obtain the desired sorting classifications is done on a mass basis at the time the cards are made out. A further advantage of Key-sort cards is that they are still

usable even if they become torn, wrinkled, etc., hence they can be issued directly to workers.

**COST RECORDS AND THE GENERAL BOOKS**—Much of the objection to tying in the cost accounts with the general books arises from the difficulty of reconciling the vast amount of detail involved in each operation. This difficulty is overcome by breaking the total job down into units small enough to be manageable. Thus, for example, the week's in and out attendance record of a department is balanced with the total of the cost department's columnar distribution sheet or other summarizing medium for this department for the week. The payroll may be charged to some such clearing account as "Direct Labor—Billing Department," and the cost department's distribution to Work in Process, by jobs is then credited to that same clearing account thus insuring their ultimate agreement. If each subdivision of labor cost is separately balanced in this way, a final recapitulation of all elements is easy to balance.

**PAYROLL ANALYSIS**—In most cases it is customary to analyze the payroll into direct and indirect labor by departments. Direct labor may be further subdivided into day work, piecework, overtime, overtime allowance, bonus, premium, etc. or in other ways to suit the operating organization and methods of the plant. Analysis of payroll figures naturally varies in different businesses according to the information desired by the executives and requirements found to exist by the accountant installing the system. Constant study and analysis of direct labor costs are important as a reduction in this expenditure often leads to savings in other elements of cost. All work that is paid for at extra rates should be subject to special attention on the part of the executive, particularly if not seasonal. No system of cost accounting is complete which does not provide a check on the effectiveness of labor employed.

Indirect labor may be subdivided into the same classifications but generally division is along lines of whether the work is chargeable to regular expense accounts or to special or appropriation orders.

**ELAPSED TIME DEFINED**—Job time recording involves a calculation of elapsed time which may be defined as the amount of time devoted to a particular unit. It may be recorded in hours and minutes, hours and fractions (usually twelfths, sixths, or quarters) or hours and decimals (six-minute intervals). It is distinct from the in and out or attendance record.

Where the decimal system is used elapsed time is figured to the nearest tenth of an hour.

Stop time	3 47	38 hours
Start time	1 23	15 "
Elapsed time		<u>23</u> "

Figures in the first column show the time in the conventional notation. The second column reduces time to decimals. Elapsed time is then obtained by simple subtraction.

**TIME RECORDERS**—There are different methods by which elapsed time is reported. Mechanical devices, such as time stamps which register the time accurately on time tickets have come into extensive

use in factories. Handwritten time books or time cards prepared by the foreman or employee are now limited principally to

- 1 Field use where it is not practical to provide mechanical timing equipment
- 2 Jobs which require days to finish and therefore do not justify precise timing

**Mechanical Job Time Recorders**—These have been developed to make the recording of elapsed time of each job as nearly error proof as possible, thus avoiding juggling or miscalculation. In addition, they facilitate, short cut, or eliminate clerical calculations. Electric job recorders located at various points in the plant, or in a central timekeeping department, are often used to stamp the start and finish times for each job. Many are equipped with 24-hour dials, starting with zero at midnight, corresponding with standard time until 12 59 P M., but showing 13 00 at 1 00 P M., 14 00 at 2 00 P M., etc. By the use of such a clock elapsed time is calculated by direct subtraction.

In one type of time recorders the first record starts at the bottom of the card, and each succeeding record is placed above the previous one (e.g., Figs 3 4, 7). With this arrangement, the ending record for the day is at the top of the day's series, and computing time for the day is a simple matter of subtracting the bottom from the top. Likewise each separate elapsed time interval is computed by subtracting the lower from the upper figure and this is entered in an adjacent column. The individual intervals can finally be added and checked with the over-all total to prove all calculations.

Another type of recorder converts hours and minutes into decimalized figures which can be more readily subtracted. To illustrate, assume that a manufacturing plant begins regular operations at 7 A M. This starting time is designated 00 by the recorder. If the lunch period starts five hours later at 12 noon, this time is designated 50, the end of the lunch period at 12 30 also is set to be recorded as 50, and the system progresses from that point. Thus if an operation is started at 9 A M. (the second working hour), the "start" imprint is 20, and if work stopped at 2 P M., the imprint shows 65. The computed difference, 45 hours automatically makes due allowance for the lunch period.

Still further progress is made by another type of recorder, the Calcu-graph, which automatically computes elapsed time from any start time to any stop time regardless of the number of tickets in process and without causing confusion between tickets. The dial can be calibrated in tenths instead of minutes, or any other fractions desired. The clock prints dials showing the exact time the job was started, time when finished, and the elapsed time (Fig 9).

Sometimes job time clocks are used to take the place of timekeepers as when the number of employees is insufficient to require full-time use of a timekeeper. Thus Taylor states (N A C A Bulletin, vol 18)

we set up a job clock and the timekeepers leave a sufficient quantity of time tickets for each man with their clock numbers entered on the cards. At the end of each job all the men have to do is ring out on the job card and ring in on a new one. One of the timekeepers goes to the clock about four times a day collects the tickets rung out, goes to the men to find out what jobs they did and the number of units produced

		EMP NO <hr/> CONTRACT NO <hr/> SERIES NO <hr/> WORK ORDER <hr/> DEPT <hr/>	
TIME EMPLOYED		COMMENCED	
NAME			
FUSELAGE	LANDING GEAR	WINGS & AILERONS	TAIL SURFACES
AIRPLANE CONTROLS	POWER PLANT	INSTRUMENTS AND EQUIPMENT	FINAL ASSEMBLY
SPECIAL			
S P O NO	DESCRIPTION		
PART NO		PART NAME	
SUB ASSEMBLY NO		PART NAME	
UNIT ASSEMBLY NO		UNIT ASSEMBLY NAME	
OK	TOTAL HOURS	RATE	AMOUNT
NIGHT SHIFT			

FIG 9 Automatic Elapsed Time Computer

These are checked against the foreman's assignments and also against shop orders and the remainder of the time ticket filled out.

**PREPRINTED TIME TICKETS**—Some concerns, upon receipt of bills of materials or blueprints have a time setter prepare a time card for each operation or each job. He shows the time allowed for the operation and machine or group of machines on which operation is to be done. The time card then serves both as a work assignment and as a record of time actually spent on the job, as compared with the time originally estimated. This method is used particularly where premiums are paid for beating the standard. It is similar to the use of prepared stores requisitions or of a bill of material, when preparing a production order.

Another arrangement is handled by the production department. With each manufacturing order the production department sends the factory an envelope containing all necessary piecework labor tickets to complete the order. These tickets show details of operations, quantity to make and piecework rate. The only information left to be put on the tickets,

185 13	459 13	459 13	459 13	459 13	459 13	459 13	459 13
12 47	12 47	12 47	12 47	12 47	12 47	12 47	12 47
09	01	18	04	06	12	05	5134
P FT	LABEL	FC MK	S D F CL	H BTR	MARK	BUTTON	CONT OFFICE
P FT	LABEL	FC MK	S D F CL	H BTR	MARK	BUTTON	CONT

MK FT	J-SLE	COL ON	FL SD	B H	BTS ON	TRIM	CONT
459 13	459 13	459 13	459 13	459 13	459 13	459 13	459 13
12 47	12 47	12 47	12 47	12 47	12 47	12 47	12 47
02	12	09	03	14	18	01	5134
MK FT	J-SLE	COL ON	FL SD	B H	BTS ON	TRIM	CONT
							FACTORY

Fig 10 Preprinted Direct Labor Ticket

in the factory is the operator's number and elapsed time, and possibly particulars as to materials used. Fig 10 is an example of such a ticket prepared on a ticketograph. Usually these tickets are produced with the aid of a complete master set of addressing plates or stencils, one plate or stencil for each direct labor operation and a set of plates for every regular stock item. When an item is to be put into production, the production department selects the set of plates for that item, prefixes an auxiliary plate showing the quantity to be manufactured and the order number, and prints the labor tickets from them. By this method all direct labor operations are controlled, as no operation can be performed without one of these printed time tickets, no pencil-written time tickets being honored by the payroll department.

**PRICING ELAPSED TIME**—Time may be extended on the basis of actual pay rates of individual employees, or at average rates for closely associated groups of employees. If individual rates are used, these rates must be transcribed to the job tickets from master rate cards showing the current and authorized rates. Probably the most economical method of pricing the hours on job tickets at individual rates of pay is through the use of prepared tables. The fastest method probably is found in connection with tabulating equipment.

**Computing Time Card and Matching Table**—A convenient shortcut in computing elapsed time is the computing time card and matching payroll table (Fig 11). This is an adaptation of the principle of using prepared tables to compute payrolls. It operates as explained on page 864.



The time card is arranged with the schedule of clock time for the entire day printed along the two edges of the card, divided into periods of six minutes or tenths of an hour. A separate time card is used for each job, and for each interval of idle or make-ready time. The employee indicates starting time by a stroke of his pencil through the clock time shown at the edge of the card, and he does the same for stopping time. This reduces to a minimum the number of clerical operations performed by workmen.

The matching payroll table is ruled to furnish a computation of figures for any rate per hour from one-tenth of an hour up to sixty tenths, or six hours. It is assumed under this system that a new time card is prepared for each elapsed period and no workman ordinarily works longer than six hours without a rest period or a lunch period, so this range is ample. Figures are filled in on the table for the hourly rates which are common in the plant. If necessary, several sheets of tables may be prepared to cover the full range of hourly rates paid different employees, although each sheet provides space for twelve rates. Separate tables are prepared for overhead rates since these tables may also be used to charge overhead costs on an hourly basis.

The time cards are accumulated in a file so as to bring the cards of each employee together for the day or payroll period. Payroll and overhead rates are entered on all cards for each employee from an appropriate master record. The elapsed time and payroll cost are then obtained by placing each time card on the computing table, as shown in Fig. 11. The card is placed beside the column for the proper payroll rate with the stroke which indicates starting time on the margin of the card laid opposite "0" on the computing table. The elapsed time and payroll cost are then read directly from the computing table opposite the stroke on the time card which indicates the finish time. Overhead cost can be read in the same manner by using the appropriate overhead rate column of the table.

The elapsed time thus entered on each day's time cards is totaled and balanced with the in-and-out time card for the day remembering that there should be cards charging overhead with idle and make-ready periods. The payroll cost on the day's job time cards is totaled and entered on the in-and-out time card as the basis for payment.

**Overtime**—Where overtime is worked at premium rates the job cards for the overtime periods can be evaluated from the table at premium rates, or the premium can be computed separately and spread with overhead, depending upon the cost practices of the establishment.

**Use of Average Hourly Rates**—Average rates per hour are used

- 1 When a number of employees at approximately the same rate of pay work interchangeably on similar operations
- 2 When one operation normally requires the joint efforts of a principal workman and a lower paid helper

In the first case, if each member of a team works at 80 cents an hour it is inefficient to price each individual ticket, and then to summarize the resulting dollar values. Instead the same mathematical result is obtained if the hours worked by the group are first summarized by jobs, products, or other classifications for an entire pay period or even for a month, at the end of which time the rate for the group is applied to the

summarized totals of the hours. Even where there is a range of pay rates (say, 75, 80, and 85 cents per hour) for various workmen, if the operations performed by all of the men are similar, there is no virtue in charging one product at 75 cents and another at 85 cents just because of the accidental assignment of a higher or lower paid man to the job. In such circumstances the hours for the group are summarized by jobs, products, etc., on one record by the cost department, and the dollar earnings of the group are summarized for a corresponding period on another record, perhaps by the payroll department. At the end of the period, the total dollars of the group divided by the total hours of the group produces an average rate per hour which the cost department can then apply to the total hours charged to each job, product, etc.

The same holds true where, for example, a workman at 80 cents an hour and his helper at 50 cents an hour work jointly at a given task. The hours of the two can be summarized for a week or month and the average rate of 65 cents an hour applied to the summarized hourly totals yields exactly the correct mathematical result with much less effort. This is substantially the method followed by the General Tire Co. where employees work on gang or pool operations. The labor cost is first computed for the job as a whole and the total apportioned among the individual workers on a percentage basis.

The use of Key-sort equipment now extensively employed on army and navy work makes possible the prepunching of rates into cards. Similar rates can then be sorted together and one bulk extension made. In general, developments in mechanical equipment to handle the immense task of preparing payrolls and labor distributions in large plants have brought about major changes in procedure and in the scope and extent of consolidation of operations and mechanization. Thus, for example, labor distributions are almost automatically obtained as a by-product of preparing the payroll and related documents on the payroll machine of the National Cash Register Company (see Section 15).

**Use of Factor Hours in Timekeeping**—Where an operator runs several automatic machines simultaneously, each machine is referred to as a "factor" and the hours it is operated are known as "factor hours." Labor costs are then computed on the basis of these factor hours. Where factor hours are involved, timekeeping methods vary as follows:

1. A single ticket is used and marked "Factor 1" or a "Factor 2" etc. to indicate the number of machines operated at various times of the day.
2. Separate tickets may be issued for each machine and each starting and stopping time indicated on each ticket.
3. In extreme cases separate tickets are made out for each machine each time there is a change in factors.

The fairest method for apportioning labor cost to production where factor hours are involved is to calculate a cost per factor hour based on a maximum or standard number of factors. For example, if an operator is expected to run three machines, and is paid \$1.00 an hour, the following factor hour cost results, assuming an eight-hour day:

1	Worker's earnings per day ( $8 \times \$1.00$ )	\$ 8 00
2	Factor hours ( $3 \times 8$ )	24
3	Cost per F.H. (item 1 — item 2)	\$ .33 1/3



The production of each machine is charged at the above standard factor hour rate. Any deficiency in labor cost due to failure of all machines to run full time is charged to an **idle time** account. In this way job costs are relieved of excess charges due to idleness of equipment. The following computation shows the resulting costs:

		Hrs Run	Product Cost	Hrs Idle	Idle Time Cost
Machine	#1	3	\$1 00	5	\$1 00
	#2	6	2 00	2	67
"	#3	8	2 67	0	0
		<u>17</u>	<u>\$5 67</u>	<u>7</u>	<u>\$2 33</u>

### Timekeeping for Indirect Labor

**MINOR REPAIRS**—Departmental mechanics, machine adjusters and tool setters performing routine functions receive a new ticket either each payroll period or each day. Their wages are as a rule charged to departmental standing orders, the code being indicated on the time ticket. Where a central repair or maintenance department furnishes repair men to other departments, the repair department timekeeper must issue a new ticket for each job showing specifically the department and standing order code to be charged.

In both the above cases, repairs are charged to the department. Production costs are charged for repairs through the application of overhead rates.

**REOPERATION LABOR**—Work condemned by inspectors as not up to specifications may sometimes be reclaimed. In such cases, time tickets made out for workers engaged in repair work on product are stamped "Repair" or "Rework" and should be of a color that distinguishes them from the regular time tickets for good work, so that the labor cost of repairs can be readily identified in the cost department and so that the quantities involved are not counted twice. The labor cost of repairing spoiled work is costed separately from the good work.

**REPORTING CAUSES OF MACHINE BREAKDOWNS**—Some plants require that the cause of machine interruptions be indicated on the mechanic's time ticket. In such cases a detailed code must be prepared showing the possible causes into which it is proposed to analyze the machine breakdown. To be of value, special reports and summaries must be prepared for use particularly of foremen. In this connection Nichols states (N A C A Bulletin, vol 22):

There is a great deal that the cost accountant can do in providing special analyses covering operations in order to make information available to foremen in the factory. By assigning special operation numbers designating the various types of special and repair operations it is a comparatively simple task to supply the foreman of any department with a report covering his department at any time. These operations are generally temporary and are performed because of one of the following conditions:

- 1 Standard machine not available
- 2 Standard tool being repaired

- 3 Standard part not available
- 4 Material not standard
- 5 Engineering or design change
- 6 Salvage or repair due to fault of operator
- 7 Salvage or repair due to improper set up
- 8 Salvage or repair due to faulty material

In some plants, direct labor engaged on piecework is paid regular day rates during the time of the machine repair. In such cases it is especially important to know the cause of the stoppages both to be able to control them and also to know what specific standing order is to be charged.

## Labor Distributions

**LABOR DISTRIBUTION AND PAYROLL ACCOUNTING**—Labor distribution accounting begins, roughly speaking, where payroll accounting leaves off. The purpose of the latter is to lay the basis for the payment of wages and salaries to the employees. By contrast labor distribution is strictly a cost function in that it assigns payroll costs to costs of production and distribution. Fig 12, taken from Van Sickle (Cost Accounting), shows the relationship between the payroll and labor distribution functions and the ultimate aim of each. The final step in payroll accounting is the creation of a charge to a Payroll account and a credit to a liability Payroll Accrued which is liquidated on pay day. The aim of labor distribution is to break down the charge to Payroll, to show its component parts, and then to make the distribution entry to close out the payroll account.

**SUMMARIZING AND POSTING LABOR COSTS MANUALLY**—In many plants most of the summarizing and posting of labor costs is done manually. The following outline represents substantially the procedure advocated in the cost manual of the National Machine Tool Builders of America.

- 1 The daily or weekly time tickets are segregated for direct labor and indirect labor. This sorting is also done for each department or cost center. Totals are entered daily on a departmental payroll analysis. The analysis may of course be made weekly or even monthly.
- 2 Totals of time tickets are checked against totals on the payroll register sheets.
- 3 The time tickets for direct labor are further sorted by jobs, classes of products, operations or processes, the totals for each subclassification are computed and posted to job cost sheets, processes, etc.
- 4 The time tickets for indirect labor are sorted by departments or cost centers and within each cost center by standing expense orders to show the analysis of the classes of indirect labor established for the plant.
- 5 Postings for indirect labor are made on a weekly or monthly basis. If weekly burden reports are required the posting is done weekly. This is preferable to monthly posting if burden costs are to be promptly and adequately controlled.
- 6 Totals of direct labor charged to production and of indirect labor charged to standing orders are checked against total earnings for the same period shown by the payroll register sheets.

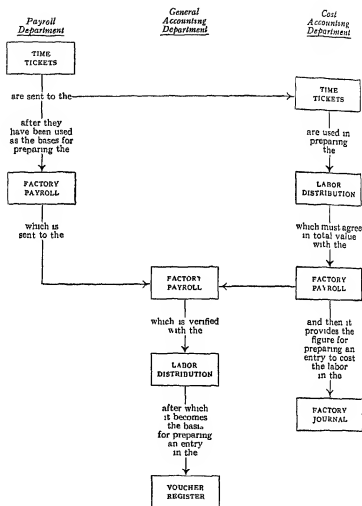


FIG 12 Relation Between Payroll Department and Cost Department

**LABOR DISTRIBUTION ENTRIES**—At the end of a week or month the departmental payroll analysis sheets are summarized on a payroll summary (Fig 13). Totals of this summary provide the information for the monthly journal voucher covering labor distribution.

JOURNAL VOUCHER				4. Week Total Period Ending Nov 30 19—
	J V Number	Period Ending Nov 7 19—		Bonus Accruals
		Factory		
Payroll Expense (Item #1 2 and 3)		25 000 00		10 000 00
Accrued Bonus (Previous Month's Accrual - Paid this Month)		5 000 00		5 000 00
Accrued Salaries and Wages (Item 2)		5 000 00		5 000 00
Federal Old Age Benefit Employees Contribution (Item 5)		25 481 00		10 474 00
Accounts Receivable - Employees (Part of Item 6)		300 00		1 0 0 00
Group Insurance		23 00		32 00
Loans		0 00		20 00
Tool Kits		10 51		49 04
Uniforms		3 79		15 10
Accounts Payable Others (Part of Item 6)		1 75		7 00
Badge and Locker Deposits		65 00		260 00
Employees War Savings Bonds		7 11		28 50
Garnishments		2 80		11 20
Hospitalization		39 000 00		10 000 00
Accrued Bonus (Current Month's Accrual-To be paid next month)				5 00 00
To summarize general and factory payrolls and to set up bonus accrual for month				
Call work order and check expensivity as well as being printed and no. to corrects from here		TOTAL		
YES _____ NO _____		CORRECT		
Support of Papers _____		APPROVED		
		POSTED		

Fig 14 Monthly Payroll Journal Voucher with Weekly Accumulations

JOURNAL VOUCHER					
I T C M	J V Number	Period Ending 5 Weeks Oct. 31 19--	Period Ending 4 Weeks Nov. 30 19--	Period Ending 4 Weeks Dec. 31 19--	Total For Year
A	Inventory - Work in process - Direct Labor		78 000 00		
B	Manufacturing Expense - Indirect Labor		19 000 00		
C	Engineering Expense		5 000 00		
D	Sales Expense		2 000 00		
E	Administrative Expense		2 000 00		
F	Deferred Charges - Time Study Expense		00 00		
G	Reserve for Vacation Allowances - Factory Payroll		1 000 00		
H	Accounts Receivable - Defense Plant Corporation (Salaries or wages directly reimbursed)		500 00		
I	General Profit and Loss - Leaders' fee (Prior period charges, etc.)		1 000 00		
Payroll Expense - Distribution					
Distribution of Monthly Payroll Expense			110 000 00		
Check <input type="checkbox"/> Cash <input type="checkbox"/> Cash <input type="checkbox"/> Cash <input type="checkbox"/> Cash <input type="checkbox"/> Cash Amount of Payroll <input type="checkbox"/> YES <input type="checkbox"/> NO		TOT L CORRECT APPROVED POSTED			

FIG 15 Distribution of Monthly Payroll Expense

MONTH of November 19—

		FROM T RAILING		FROM PAYROLL DEPT		FROM BONUS DEPT		Total to Journal Voucher (Fig 14)
		Direct Labor	Indirect Labor	Office Premium	Vacation Payments	Labor Bonus	Indirect Labor Bonus	
A	Inventory—Work in Process	\$70 000				\$8 000		\$ 78 000
B	Manufacturing Expense		\$10 000	7 000			83 000	19 000
C	Engineering Expense		4 000	1 000				5 000
D	Sales Expense		2 000	600				2 600
E	Administrative Expense		2 000	500				2 500
F	Deferred Charges		500					500
G	Reserve for Vacations				\$1 000			1 000
H	Accounts Receivable—Direct Charge		500					500
I	General Profit and Loss		1 000					1 000
	Payroll Expense Distribution	70 000	20 000	9 000	1 000	8 000	2 000	110 000

FIG 16 Work Sheet for Distribution of Payroll Costs

numbers on the voucher refer to similarly numbered items on the payroll summary. Columns are provided on the voucher to record weekly totals. Bonuses are accrued only at the end of each month. A grand total column for the fiscal period is provided. Note that the debit in Payroll Expense of \$110,000 is offset in Fig. 15 by a credit for the same amount.

Fig. 15 is based on a work sheet (Fig. 16) which accumulates the necessary monthly figures from

- 1 Tabulating Department
- 2 Payroll Department
- 3 Bonus Department

The tabulating department sorts and tabulates the distribution cards for direct and indirect labor. The resulting charges on Fig. 15 are to

- 1 Inventory—Work in Process—Direct Labor (item A)
- 2 Various distribution accounts (items B to I inclusive)

The payroll department accounts for overtime and vacation payments. Overtime is charged to the same distribution accounts (items B to I Fig. 15). Vacation payments are debited to a Reserve for Vacation Payments. The bonus department accounts for bonuses earned by factory direct and indirect labor. The first is charged to Work in Process, the second to Manufacturing Expense.

## Short-Cuts in Labor Costing

**TYPES OF SHORT-CUTS**—The possibility of simplifying labor cost routine is one that must be studied anew in each plant. The major possibilities in this respect are

- 1 Combining payroll and timekeeping records
- 2 Use of mechanical equipment to produce several required records in a single operation
- 3 Use of various types of mechanical equipment to simplify timekeeping and cost routine by preprinting standard information on time tickets by abolition of time tickets, etc.

**COMBINING CLOCK RECORD AND LABOR DISTRIBUTION**—Conventional methods call for in-and-out clock record and use of separate time tickets. This makes it necessary for two sets of clerks to handle the records and then to reconcile the figures obtained by each section. By combining both types of record into a single form reconciliation of labor charges and payroll earnings becomes automatic. Fig. 4 is an example of such a combination, which has become popular. Of course unit distribution tickets provide greater flexibility since they can be sorted in any desired subclassification. The combination tickets cannot be sorted by account numbers at all and postings must be made directly from the ticket. A more flexible arrangement, however is illustrated in Fig. 17 adapted from one used by a tire manufacturer. This method has the advantages of a combination record and the flexibility of unit distribution tickets. The work of this company is divided into 26 departments with approximately 700 different labor charges. This makes the problem of costing labor operations particularly acute.



N <sup>o</sup> 51171	50 759							
	HENRY JONES							
3								
<i>Henry Jones</i> 10 " 7 1/2						FOREMAN'S APPROVAL		
						8 1/2		
201	50	N <sup>o</sup> 51171						
120	007	84						
12								
216	65	N <sup>o</sup> 51171						
60	012	.72						
7								
230	80	N <sup>o</sup> 51171						
140	009	126						
9								
203	52	N <sup>o</sup> 51171						
80	021	168						
15								
224	63	N <sup>o</sup> 51171						
177	013	230						
16								
218	71	N <sup>o</sup> 51171						
	110	132						
12								

FIG 17 Combined Clock Record and Cost Coupons

The top of Fig 17 is used as a clock card and also as a payroll stub. It shows clockings, employee's name and number, shift and group number, total hours worked, and total earnings for the day. Below the payroll stub are six cost coupons, showing, production, time spent, rate amount earned, charge and operation number, for each job worked on during the day. The employees are paid on a piecework basis supplemented by a basic hourly rate. Where necessary, time slips are used to supplement time cards in case an employee performs more than six different operations in a day. The information on the time cards is filled out as completely as possible by the employees themselves, but must be checked and approved by the foremen or timekeepers. At the close of the day the cards are hung out and placed in a locked box. Each morning the cards are picked up by the timekeeping department and checked as to time between clockings, quantities, charge numbers, operation numbers, and rates. The cards are then sorted to departments, or to groups of employees within larger departments.

Extensions on time cards are handled by electric calculators. Hours and earnings are added and the totals immediately checked against the figures on the payroll stubs. At the same time, the machine accumulates the departmental totals automatically. These departmental totals are then posted to a payroll control sheet. At the end of each weekly period, the totals on the control sheet are added to obtain a grand total against which to balance the payroll.

The same company cited above uses different periods as a basis for labor distribution. When the rate of production in a department is

stubs only once a week to employees' earnings cards.

At the end of the month, labor charges are totaled by adding the columns on the labor distribution sheets. Grand totals for the labor distribution sheets, payroll control sheet, and employees' cards are now in balance.

**USE OF JOB TIME RECORDERS**—Similar to the General Tire Co.'s plan is that explained by Totten (N.A.C.A. Bulletin vol 22). The time card used is shown in Fig 18. It differs however from the previously described scheme in the following respects:

- 1 On Fig. 18 the clock number must be written in on each coupon while in Fig 17 use of a preprinted identification number on coupon and payroll stub makes repeated writing of the clock number unnecessary
- 2 Coupons on Fig 18 can be separated along perforated edges instead of being cut with a cutter
- 3 Coupons on Fig 18 are more complete and show start and stop time on each coupon Small electric job recorders located at various places in the plant, are used to stamp in and out time as well as job time

A modification of the right-hand side of the time card shown in Fig 18 to permit manual job time recording, appears in Fig 19 Each night upon leaving the plant, the employee leaves his ticket in a place provided for it, and a clerk from the office collects it The payroll clerk extends the hours worked from the elapsed time as printed on the job tickets and balances these hours and dollars with the in-and-out time at the top of the report The job coupons are then detached for sorting and summarizing while the in-and-out portion is used for preparation of payroll records

**USE OF GANG SHEET**—Fig 20 extends the use of a combined clock and job time record to an entire department It may also be used as a gang sheet In this arrangement each coupon represents a definite job or operation, during the day time spent by anyone in the department or gang on a specific job is extended to the appropriate coupon strip Clock time is recorded at the left Grand totals for the day appear at the top just below the foreman's approval and are cross checked to the distributions A preprinted identification number makes repetition of the clock numbers on the coupons unnecessary

**PREPARATION OF RELATED RECORDS IN A SINGLE OPERATION**—Most attempts at short-cutting labor cost operations combine payroll accounting and labor costing in one form or another Use of special mechanical equipment predominates in all such case A typical illustration is furnished by North (NACA Bulletin, vol 18) Labor cost cards (Fig 21) are made out by a central timekeeping department on information furnished by foremen According to North

The card is placed in a rack under the clock number of the man working on the job This card remains in the rack until the job is completed, when it is replaced with a new card showing the new operation, or until the end of the pay period On removal the card is put through the time recorder and the number of periods elapsed is calculated and written in by the timekeeper

Note that the worker does not handle the labor card Upon completion of the job, or at the end of a pay period, the labor cards are sorted by clock numbers in the payroll department and Addressographed payroll sheets and pay check are prepared Clock cards are also run through the Addressograph to imprint rates recurring deductions, etc (Fig 22) These records including the clock and labor cards are then put through a typewriter calculating machine where cost extensions are made and the payroll written and proved in one operation

First the rate is entered in the machine, and labor cards are inserted in the machine and successively extended The figures are accumulated in



					El p d Time	Cost	
8	6	12	18	24	30		
	36	42	48	54			
10	6	12	18	24	30	25	
	36	42	48	54			
10	6	12	18	24	30		
	36	42	48	54			
12	6	12	18	24	30	15	
	36	42	48	54			
13	6	12	18	24	30		
	36	42	48	54			
14	6	12	18	24	30	15	
	36	42	48	54			
14	6	12	18	24	30		
	36	42	48	54			
17	6	12	18	24	30	25	
	36	42	48	54			
18	6	12	18	24	30	10	
	36	42	48	54			
20	6	12	18	24	30	20	
	36	42	48	54			

FIG 19 Portion of Cost Coupon for Manual Time Recording

the machine and the total cleared to the clock card. The operator then multiplies the regular time and overtime on the clock card by the rate, subtotalling the gross pay, enters and subtracts the deductions, and prints the net pay on all related documents in one operation. The payroll register entries are produced simultaneously as successive clock cards and pay checks are fed into the machine. North states:

If the amount distributed to cost agrees (within a cent or two to allow for fractional amounts) with the straight time total, we are assured that, (1) the rate has been correctly used on the job cards and on the clock card, (2) the periods on the job cards in total agree with the periods on the clock card, and (3) that the labor cost distributed is in agreement with the payroll accrued.

**ABOLITION OF JOB TIME TICKETS**—Further modification of labor costing is possible through the complete abolition of time tickets. The method is described by Henshaw (N A C A Bulletin, vol 20). The company in question manufactures many types of advertising signs. The system is built around the use of Telautograph combination sending and receiving machines installed in the shop. A similar set with auxiliary receiver was installed in the office. Instead of using time tickets, each machine operator writes the original labor record on the shop trans-

NO 8944		NO 8944		NO 8944		NO 8944		NO 8944		NO 8944		NO 8944		NO 8944	
DIP. RTMENT 14		DATE 9-10		DIP. RTMENT 14		DATE 9-10		DIP. RTMENT 14		DATE 9-10		DIP. RTMENT 14		DATE 9-10	
P. C. Brown		DATE 9-10		DIP. RTMENT 14		DATE 9-10		DIP. RTMENT 14		DATE 9-10		DIP. RTMENT 14		DATE 9-10	
GR. NO. TOTALS	485	39.15	10	2160	11	8 65	8 1/2	6 70	7	5 65	12	10 55			
NAME AND NUMBER		DATE		DIP. RTMENT		DATE		DIP. RTMENT		DATE		DIP. RTMENT		DATE	
Joe Brown		DATE 9-10		DIP. RTMENT 14		DATE 9-10		DIP. RTMENT 14		DATE 9-10		DIP. RTMENT 14		DATE 9-10	
REGULAR TIME	8 60	4 50	3	1 70	2	1 20	1	60	2	1 20					
OVERTIME															
TOTAL															
CLOCK NO. 247		DATE 9-10		DIP. RTMENT 14		DATE 9-10		DIP. RTMENT 14		DATE 9-10		DIP. RTMENT 14		DATE 9-10	
Henry Carpenter		DATE 9-10		DIP. RTMENT 14		DATE 9-10		DIP. RTMENT 14		DATE 9-10		DIP. RTMENT 14		DATE 9-10	
REGULAR TIME	8 70	5 60	1	70	3	2 10	2	1 40		2	1 40				
OVERTIME															
TOTAL															
CLOCK NO. 350		DATE 9-10		DIP. RTMENT 14		DATE 9-10		DIP. RTMENT 14		DATE 9-10		DIP. RTMENT 14		DATE 9-10	
G. C. Lee		DATE 9-10		DIP. RTMENT 14		DATE 9-10		DIP. RTMENT 14		DATE 9-10		DIP. RTMENT 14		DATE 9-10	
REGULAR TIME	8 70	6 40	2	1 60		2	1 60	2	1 60	2	1 60				
OVERTIME	2 10	2 40													
TOTAL															
CLOCK NO. 261		DATE 9-10		DIP. RTMENT 14		DATE 9-10		DIP. RTMENT 14		DATE 9-10		DIP. RTMENT 14		DATE 9-10	
L. Smith		DATE 9-10		DIP. RTMENT 14		DATE 9-10		DIP. RTMENT 14		DATE 9-10		DIP. RTMENT 14		DATE 9-10	
REGULAR TIME	7 10	6 10	3	2 70	1	90				3 10	3 10				
OVERTIME															
TOTAL															
CLOCK NO. 255		DATE 9-10		DIP. RTMENT 14		DATE 9-10		DIP. RTMENT 14		DATE 9-10		DIP. RTMENT 14		DATE 9-10	

Fig 20 Gang Sheet for Job Distribution and Payroll

NO		NAME		MA	
CREDIT NO		C 6810		CREDIT	
DATE		12/15/56		3 MARK 01	
NAME		Banta		3 MARK 01	
NAME IN USE		A 1256		3 MARK 01	
PCL. NUMBER		A 1256		3 MARK 01	
TO ALLOWED		10 MARK 481		3 MARK 01	
DATE		4/00		3 MARK 01	
LUMPS		63		3 MARK 01	
NO. EMPLOYEES		25.20		3 MARK 01	
NO. EMPLOYEES		13.42		3 MARK 01	
NO. EMPLOYEES		31.94		3 MARK 01	
NO. EMPLOYEES		6.93		3 MARK 01	

CARD TOTALS  
AUTOMATICALLY  
ACCUMULATED  
AND TOTALLED  
(See Fig 22b )

FIG 22a Combined Labor Costs and Payroll Computation

NO		IN N		G C	
CREDIT NO		70129		CREDIT	
NAME		Mach		CREDIT	
NO. EMPLOYEES		7		CREDIT	
PCL. NO.		27 APR 348		CREDIT	
TO ALLOW		27 APR 320		CREDIT	
DATE		28		CREDIT	
LUMPS		28		CREDIT	
NO. EMPLOYEES		28		CREDIT	
NO. EMPLOYEES		28		CREDIT	

FIG 21 Labor Cost Card





CLOCK NO.		NAME		WEEK ENDING									
				FRIDAY		SATURDAY		SUNDAY				PAYROLL SUMMARY	
TIME	HOURS	EXT	JOB NO	TIME	HOURS	EXT	JOB NO	TIME	HOURS	EXT	JOB NO	DAY	AMOUNT
IN												MONDAY	
OUT												TUE DAY	
IN												WEDN DD	
OUT												THUR D	
IN												FRI Y	
OUT												SATUR Y	
IN												OVERTIME	
OUT												TOTALS	
IN												DEDUCTIONS	
OUT												ACCOUNT	
IN												SS	
OUT												BANK	
IN												RE	
OUT												UNION	
IN												CASH	
OUT												TO BE PAID	
IN												SUMMARY NON PROD LABOR	
OUT												CC	
IN												HR	
OUT												MO	
IN												S	
OUT												EXT	
IN												TOTALS	
OUT													
TOTALS													

Fig 23 Payroll Record





mitter which simultaneously reproduces the same record on the receiver in the office. There an operator posts information to

- 1 Individual payroll record (Fig 23)
- 2 Job cost sheet (Fig 24)

Fig 23 is the reverse side of the payroll record, the face of the form showing payroll accumulations for the first four days of the week. Time is posted in tenths of hours, direct and indirect labor are shown separately. Fig 24 shows the face and reverse sides of the job card. The face of the card provides a complete record of the progress of the job from the time the contract is received until the finished sign is shipped. Scheduled dates of arrival of the job in departments and actual dates are indicated. This feature facilitates production control as well as cost control. The balance of the card reveals actual departmental costs, the allowed costs being indicated at the head of each column.

One office clerk has been able to handle both records for more than 150 shop employees. According to Henshaw this simple scheme of labor accounting is "not only the fastest method but also the most complete and the least expensive method of any" the particular shop has tried. It has "eliminated all payroll and cost reconciliation problems because both records are kept simultaneously in the same spot, by the same operator."

## Excess Labor Costs

**NATURE OF PROBLEM**—Among recent widely discussed problems is that of excess labor costs. Such costs can be "excess" only as compared with some standard or normal costs. Hence the expression is commonly used to refer to labor costs resulting from conditions connected with the war emergency, many of which may disappear with the passing of the emergency. The question resolves itself, therefore, into a consideration of which among the recent economic, industrial, and social changes are temporary and which must be incorporated into a conception of normal costs. So far as inventory valuations are concerned it is considered sound policy to exclude excess labor costs from valuations or in other words to write off promptly as expense all such costs incurred so that they will not be deferred, through the inventories to the costs of subsequent years. This is a lesson learned from the experience of business in previous periods of rapidly accelerated production. It is merely a recognition of the fundamental fact that profits cannot be finally determined for a short accounting period, but only when all of the transactions arising within that period have become closed (i.e. completed) transactions.

Certain of the increased costs, particularly those related to the immediate compensation of labor as well as the costs related to the protection of labor against old age, unemployment, etc. may prove to be permanent and will have to be built into the normal cost structure. Such economic changes, reflecting changing social concepts may well bring about a reclassification of items at present referred to as excess labor costs and may also change current practices as to the classification of the elements of direct and indirect labor costs.

**TYPES OF EXCESS LABOR COSTS**—Extra or excess labor costs include such items as

- 1 Overtime premiums
- 2 Premiums paid to night shift workers where there are multiple shifts which have ordinarily been in effect
- 3 Wage increases above normal
- 4 Cost of employee training programs where the personnel has increased considerably above normal
- 5 Unusual inefficiencies in shop labor etc

Cost men agree on certain fundamentals with regard to the accounting treatment of excess labor costs

- 1 They should be segregated (the wage and hour law requires the separate recording of regular hours and overtime hours)
- 2 In a determination of actual cost all elements of cost incurred must be included. Hence excess labor costs should be reported as actual costs under government contracts since the government requires reporting of actual costs in negotiated contracts

**CHARGING EXCESS COSTS TO PRODUCT**—Excess labor costs lend themselves to a variety of treatment. A fundamental conflict exists as to whether to charge the product directly or to charge the period (i.e., Profit and Loss). The question is important because it involves principles of inventory valuation as well as the distribution of profits and losses between fiscal periods. The principle seems to be well established that all nonrecurring or extraordinary items are to be dealt with separately by the management. The latter may wish to know the actual costs of products or contracts for purposes of control of operations or price negotiations, but it must also know those elements of cost beyond its control and which, while related to the product, are more in the nature of immediate losses than recurring costs. The situation is analogous to the results produced by standard cost systems in which excess costs are obtained for all elements of costs including not only labor, but also material and overhead, in the form of variances for labor, material overhead, and idle capacity. These by long custom have been segregated from product costs in the accounts.

The subject is discussed in NACA Bulletin (vol. 23) which states in part

costs previously recognized as product costs are eliminated from product values and absorbed currently whenever it appears that the cost thus deferred in inventories may not be realized through the subsequent sale of the product

The same authority urges elimination of excess labor costs from product cost to prevent fictitious enlargement of war profits, with consequent necessity for inventory write-downs after the war.

**CHARGING AND ALLOCATION OF OVERTIME PREMIUMS TO PRODUCTS**—When overtime is to be charged to production, there is still the question whether it should be charged specifically or generally. If the plant is engaged in a single large project such as the construction of a ship, all overtime may be charged to it. But in the majority of cases, overtime is required because of the over-all situation that is, the jobs that need to be done. In other words, not one

job but all jobs are responsible for overtime. Therefore, the overtime should be spread over all production. Wilson (N. A. C. A. Bulletin, vol. 23) states that in the airplane industry, overtime compensation is regarded as direct labor cost and is distributed as such among the various jobs in the shop. He points out, however, that other companies charge the extra compensation to the job being worked on during the overtime hours. His organization has therefore developed the following procedure:

- 1 Total hours and total pay earned including overtime compensation, are computed
- 2 Total pay is divided by total hours to compute the average effective cost per hour
- 3 This effective rate per hour is applied to all jobs worked on during the period

A special government bulletin (Explanation of Principles for Determination of Costs under Government Contracts) provides that where overtime is charged as direct labor, care must be exercised if overhead is based on labor cost, to exclude the excess direct labor cost from the calculation base.

**Normal Overtime**—Not all overtime is unusual. Some machinery and equipment is operated normally for a production cycle of twenty-four hours or at least for substantially more than eight hours. Examples in point are case hardening, gas and electric furnaces, brass dipping and drying, galvanizing, lacquering and plating. The same holds true in foundries where cleaning and grinding, after the melt is run off, are done by the night shift which is paid a premium. Such costs are part of the

#### PRACTICE IN ACCOUNTING FOR DIRECT LABOR OVERTIME PREMIUMS

(With respect to inclusion in or exclusion from goods in process and finished goods inventories)

Practice Followed	Number of Companies
Overtime premiums included in inventory values	
As a cost of direct labor	98
As an element of manufacturing burden	43
By division of variance account containing overtime premiums between inventories and profit and loss	11
Total included in inventory values	<u>122</u>
Overtime premiums excluded from inventory values	
Through original entry as variance closed to profit and loss	10
Through treatment as direct labor variance, closed to profit and loss	23
Through treatment as burden variance, closed to profit and loss	45
Total excluded from inventory values	<u>78</u>
Normal allowance for overtime premiums included in inventory values	
By including as an element of manufacturing burden	63
Total companies	<u>263</u>

FIG. 25 Inventory Values in Relation to Overtime Premium

regular costs of production. Thus the research department of the N A C A reports (N A C A Bulletin, vol 23)

It seems to be rather generally agreed that the normal costs involved in overtime night shifts and increased employee training are true costs of production and proper additions to the value of inventories

**Overtime Premiums on Direct Labor**—This problem may be viewed from two angles

- 1 Propriety of including overtime premiums in inventory values
- 2 Specific element to which premiums are to be charged

Fig 25 shows the results of a research study made by the National Association of Cost Accountants (N A C A Bulletin, vol 22). A considerable majority, though using different methods, nevertheless include overtime premiums in inventory values

A different analysis is based on the specific method of charging such premiums. The research study shows the following results

	Number	%
1 Original charge to direct labor	99	38
2 Element of factory overhead	154	58
3 In variance account closed to Profit and Loss	10	4
Total	<u>263</u>	<u>100</u>

**Overtime Premiums on Indirect Labor**—The same research study referred to above shows the treatment of overtime premiums for indirect labor as follows

1 Companies including estimated total premiums in inventory values	73
2 Companies excluding overtime premiums from inventory values	88
3 Companies including a normal allowance for overtime premiums in inventory values	79
4 Inclusion in manufacturing burden but did not indicate whether included in burden rate	20
5 Excluded from overhead (shown in variance account closed to Profit and Loss)	3
Total companies	<u>203</u>

**Night Shift Premiums**—A night shift premium rate is a specific increase in pay over the regular or base pay. It is either a specified amount per hour or it is expressed as a percentage of regular pay.

The N A C A research study showed that of 145 companies paying night shift premiums, 83 absorbed the cost in inventories, 57 charged them against current income, and 5 explained their practices as follows

- 1 Normal amount included in inventories excess over normal written off currently
- 2 Premiums paid direct labor included in inventories premiums paid indirect labor written off currently
- 3 Burden rates are established at normal. If normal requires night work, premium is included in standard overhead and consequently in inventories

- 4 In departments where multiple shifts are usual the premium is included in normal overhead rates otherwise charged to current operations as unliquidated overhead
- 5 In departments operating normally in two or three shifts it is included in costs and inventories. In others it is included in burden and treated in the same way as overtime (a Profit and Loss variance)

The special government bulletin mentioned above states

Special premiums, bonuses and overtime payments if treated as direct labor costs should be separately stated. Furthermore, if direct labor cost is the basis of overhead apportionment such special premiums, bonuses and overtime payments should not be included in the base for the distribution of overhead.

**EMPLOYEE TRAINING PROGRAMS**—Employee training programs including apprenticeship training have been accelerated by the war. In the N. A. C. A. study of 134 companies who answered questions in regard to the accounting treatment of the costs of employee training 59 included such costs in inventory values and 75 charged them to Profit and Loss. The general tendency is for companies maintaining regular apprentice courses to charge them as part of normal overhead, which in turn finds its way into inventory. On the other hand abnormal or excess costs of an unusual period (such as the war period) are not to be capitalized.





## SECTION 17

### OVERHEAD ACCUMULATION

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## SECTION 17

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# OVERHEAD ACCUMULATION

### Definitions

**MANUFACTURING EXPENSE**—Manufacturing expenses embody all items of production cost exclusive of raw materials and direct labor. The latter two items combined are termed prime cost. Superimposed upon prime cost is a class of indirect or general expenses which, though pertaining to manufacturing, cannot be charged directly to the product. These expenses are termed manufacturing expense or burden. For example in the manufacture of 10 bronze bushings to customer specifications the raw material cost of bronze castings can be definitely ascertained. Likewise direct labor cost involved in machining castings can be exactly computed. But it is impossible to identify as part of the cost of these bushings the exact cost of supervision, production control, power, blueprinting, and many other services all of which are essential elements of a well organized plant.

The term overhead expenses is commonly used as a synonym for burden. It is a collective term that includes all items of manufacturing expense. Other synonyms are factory expense, plant expense, plant and service expense, factory overhead, oncost, etc. By whatever name these expenses are known, they represent the most important topic in the field of cost accounting.

**FACTORY SERVICE**—Dohr, Inghram, and Love (Cost Accounting) indicate a general dissatisfaction with the terms in use to designate factory overhead, and suggest the term factory service as being more descriptive.

The indirect expenses are variously referred to as nonproductive cost, burden, oncost, loading or overhead. It is suggested that the terms applied to indirect costs are entirely inappropriate. Burden for instance suggests something undesirable or onerous. Nonproductive cost suggests the idea of waste or uselessness. Loading suggests something bothersome or unnecessary. As a matter of fact the goods or services as a result of indirect expenditures are quite as necessary and useful as the direct costs. The indirect group includes all costs necessary and incident to the maintenance of a properly equipped and properly operated factory or plant and factory service may therefore be regarded as a useful factor in cost along with materials and labor service. The element of factory service in costs represents the charge for use or utilization of plant service capacity.

**OVERHEAD COST**—This term signifies overhead expense which has been charged into work in process, it is more commonly referred

to as applied expense or applied burden. Under some types of cost accounting systems, total actual expenses each month are charged to production and thus become costs in their entirety for the same month. In other types expenses are charged to the product at predetermined rates, the resulting costs being either less or greater than actual expenses, (see Sections 19 and 20 for overhead applied to production)

**ACCOUNTING FOR MANUFACTURING EXPENSE**—All manufacturing expense items must first be accumulated as a total. They must be distributed, in turn, to the proper manufacturing departments, and then applied to the product by one or more of a number of different methods available for that purpose. The accumulation of plant expenses embraces accounting procedures for these items up to the point where they are, in turn, distributed to production and service departments. The successive steps in expense accumulation are

- 1 Analyzing transactions involving these costs
- 2 Entering transactions on original records and summary sheets
- 3 Journalizing transactions in proper books of original entry
- 4 Posting transactions to proper subsidiary expense accounts
- 5 Posting transactions to proper control account or accounts
- 6 Proving balance in plant and service expense control account with aggregate of subsidiary ledger account balances

## Primary Manufacturing Expenses

**BASES OF EXPENSE CLASSIFICATIONS**—There are various bases for classifying manufacturing expenses. These however are not distinctive within themselves, but are overlapping and interrelated. Plant expenses may conveniently be classified according to

- 1 Primary accounts based on the nature or object of expenditure
- 2 Functions in relation to departmental activities
- 3 Behavior with respect to degree of variability

**PRIMARY MANUFACTURING EXPENSE ACCOUNTS**—Factory overhead or expense accounts are kept in a manufacturing expense ledger, to which postings are made monthly. In order to differentiate these expenses from expense classifications on a functional basis, they are often referred to as primary expenses. A typical subdivision of primary manufacturing expenses is shown below. It represents the classification recommended in the Uniform Accounting Manual of the Electrical Manufacturing Industry. The arrangement and classification shown there are generally similar to arrangements recommended in the uniform accounting manuals for machinery manufacturing and gear manufacturing industries.

- |                           |                           |
|---------------------------|---------------------------|
| 31 Salaries and Wages     | 35 Maintenance            |
| 32 Operating Supplies     | 36 Fixed Charges          |
| 33 Other Factory Expenses | 37 Power, Heat, and Light |
| 34 Rendered Service       | 38 Sundry Expenses        |

These major primary account groups are subdivided and many of the subdivided accounts are further divided as shown on the following page

### Indirect Manufacturing Expenses

<b>SUBGROUP 31 SALARIES AND WAGES</b>		3524 Conveyer Locomotives	
311 Supervision		3525 Small Tools	
3111 Supervision		3526 Electrical Accessories	
3112 Foreman and Assistants		3527 Molds, Pops, and	
3113 Inspectors		Special Tools	
312 Clerical Employees		3528 Metal Flasks	
313 Service Employees		353 Foundations	
3131 Elevator and Crane Operators		3531 Foundations for Machinery and	
3132 Stockkeepers and Helpers		Electrical Apparatus	
3133 Tool Cut Attendants		354 Furniture and Fixtures	
3134 Helpers and Laborers		3541 Factory Fixtures and Equipment	
3135 Railway Employees		3542 Furniture and Appliances in Fac-	
3136 Chauffeurs and Garagemen		tory Office	
3137 Overtime Allowances		355 Transportation Systems	
<b>SUBGROUP 32 OPERATING SUPPLIES</b>		3551 Roads and Sidewalks	
321 Fuel Consumed		3552 Railway Tracks and Overhead	
322 Nondurable Tools		Equipment	
323 Shop Supplies		3553 Rolling Stock	
324 Inspection and Supplies for Lighting		3554 Automobiles and Trucks (Gas)	
and Electrical Equipment		3555 Electric Vehicles and Trailers	
325 Office Supplies		3556 Other Conveyances	
<b>SUBGROUP 33 OTHER FACTORY EXPENSES</b>		356 Patterns	
331 Personnel Service		<b>SUBGROUP 36 FIXED CHARGES</b>	
3311 Accident Service		361 Depreciation	
3312 Hospital Service		362 Taxes	
3313 Employee Education and Work		363 Other Fixed Charges	
3314 Employees Representative		3631 Insurance Property	
3315 Employees Suggestion Awards		3632 Rentals	
3316 Employment Bureau		3633 Accident Compensation	
3317 Personal Service Re-creation		3634 Shop Vacation Allowance	
3318 Restaurant Operations		3635 Group Insurance	
3319 General Welfare		3636 Supplementary Compensation	
332 Unassigned Transportation and Pack-		3637 Taking Inventory	
ing (Incomm.)		3638 Establishment Charges (Lea-	
333 Packing (Outgoing)		dated)	
334 Shop Losses		3639 Penalties	
335 Sundry Other Manufacturing Ex-		<b>SUBGROUP 37 POWER HEAT AND LIGHT</b>	
penses		371 Operating Employees	
3351 Rearrangement of Equipment		3711 Supervision	
3352 Telephone and Telegraph		3712 Clerical Employees	
3353 Tracing Expense		3713 Service Employees	
3354 Plant Protection		372 Operating Supplies	
3355 Grounds and Gardens		3721 Fuel Consumed	
3356 Instruction of Apprentices		3722 Steam	
3357 Other Manufacturing Expenses		3723 Water	
<b>SUBGROUP 34 RENTED SERVICE</b>		3724 Lubricants	
341 Purchasing Department		3725 Nondurable Tools	
342 Receiving Department		3726 Other Supplies	
343 Storekeeping Department		373 Maintenance	
344 Shipping Department		3731 Buildings	
<b>SUBGROUP 35 MAINTENANCE</b>		3732 Steam Plants	
351 Building and Structure		3733 Engines and Turbines	
3511 Office Buildings		3734 Electrical Plant	
3512 Other Buildings		3735 Other Maintenance	
3513 Structures		374 Fixed Charges	
3514 General Service Piping, and		3741 Depreciation	
Wiring		3742 Taxes	
352 Machinery and Tools		3743 Insurance	
3521 Machinery		3744 Rentals	
3522 Electrical Apparatus		3745 Assessed Charges	
3523 Ovens and Furnaces		379 Other Operating Expenses	
<b>SUBGROUP 36 FIXED CHARGES</b>		<b>SUBGROUP 38 SUNDRY EXPENSES</b>	
361 Depreciation		381 Assessed Charges	
362 Taxes		382 Expense Credits	
363 Other Fixed Charges			
3631 Insurance Property			
3632 Rentals			
3633 Accident Compensation			
3634 Shop Vacation Allowance			
3635 Group Insurance			
3636 Supplementary Compensation			
3637 Taking Inventory			
3638 Establishment Charges (Lea-			
dated)			
3639 Penalties			

From the preceding primary expense classification note the following

- 1 That the major expense accounts may be subdivided into numerous more specific subaccounts
- 2 That these factory expense accounts embody a multitude of detailed expense charges which are made thereto
- 3 That some of the classification merge into departmental accounts notably subgroup 34 representing various service department charges

The extraordinarily large number of plant expense accounts required by an industrial concern is illustrated by the chart of overhead accounts used by rubber manufacturers (Uniform Accounting Manual of the Rubber Manufacturers Association)

### Overhead Expense Accounts

EXPENSE MATERIALS, SUPPLIES AND MISCELLANEOUS	INDIRECT LABOR (Cont d)
Office and Stationery Supplies Printer's Shop Supplies Operating Supplies Cafeteria Supplies Mechanical Supplies Packing and Shipping Supplies Garage Supplies Coal and Fuel Oil Lubricants Instrument Repair Parts and Supplies Miscellaneous Tools Liners and Wraps Purchased Power Rental of Equipment Unabsorbed Freight Demurrage Donations and Subscriptions Books and Periodicals Telegraph and Telephone Association Dues Licenses Autos Drivers Engi- necers and Elevators Traveling Expense Provision for Pensions Miscellaneous	General Watchmen Sweepers and Cleaners Inspectors Elevator Operators Truckers Scrap Collectors and Sorters Cleaners and Oilers Weighers and Checkers Taking Inventory Repairing Slight Defects Allowances Instruction and Learning Time Allowed Overtime Allowance Minimum Wage Allowance Idle Time Waiting Time No Material Poor Material Improper Routing of Material Machine Breakdown No Power No Work Accident Education Athletics Sickness Molds Liners and Air Bags Changing Molds Cleaning Molds Cores etc Liners Labor Test and Store Air Bags Power Labor Firemen Engineers Coal Passers Unloading Coal Substation Attendants Switchboard Operators Meter Men
INDIRECT LABOR Supervision Salaries Executives Superintendents Division Foremen Foremen and Subforemen Office and Clerical Clerks Paymasters Timekeepers Draftsmen Stenographers Messengers	

Overhead Expense Accounts (*Cont d*)

INDIRECT LABOR ( <i>Cont d</i> )	REPAIRS AND MAINTENANCE
Welfare Factory Council Salaries Health Salaries Cafeteria Labor Technical Chemists and Assistants Testers Experimental and Development Shops Garage and Yard Shop Labor Tool Crib Attendants Cutting Dies Labor Garage Labor Yardmen Snow and Ice Removal Stores and Packing Stores Handlers Packers and Shippers Repair Goods	Land Improvements Building Machinery and Equipment Molds Cores and Poles Liners and Wraps Small Tools Furniture and Fixtures Autos and Auto Trucks
DEPRECIATION	INSURANCE
Land Improvements Buildings Machinery and Equipment Molds Cores and Poles Liners and Wraps Furniture and Fixtures Autos and Trucks	Compensation and Liability Fire Fidelity Bond Tornado Use and Occupancy Payroll Robbery Boiler Explosion Plant Explosion Riot and Civil Commotion Elevators Automobile
	TAXES
	Land and Building Personal Property
	ROYALTIES

More classification of accounts does not of itself solve anything. It is necessary to know the *datum* content of each account, and to insure uniform distribution of charges by the issuance of instructions through a suitable manual. The following illustration is taken from the same manual cited above:

- 334 Shop Loss Accounts—This is subdivided as follows
- 3341 Defective Workmanship—This account is charged with losses due to defective workmanship, e.g. operator's errors, carelessness, blunders, etc.
- 3342 Defective Purchased Material—This account is charged with losses due to defective materials either bought outside or received from another works or district.
- 3343 Other Losses Due to Errors—This account is charged with losses due to errors of clerical employees e.g. replacement of lost material materials ordered incorrectly, ordering or producing in excess of requirements, expense of cutting down stock materials to standard stock sizes when sufficient material is not available of the stock sizes required, expense of cutting down stock materials to special nonstock sizes when it is impossible to wait until the special size can be bought outside, loss on materials or apparatus damaged or lost in transportation between departments, etc.

The extent of subdivisions in major expense accounts varies with the industry, the individual plant, and the degree of detailed information



desired. The following list illustrates the possibilities of subclassifications.

**Factory Supplies**—Factory supplies include scores of different expense items. A typical classification covers

- |                     |                                |
|---------------------|--------------------------------|
| 1 Chemicals         | 5 Lubricating Supplies         |
| 2 Containers        | 6 Foundry Supplies             |
| 3 Janitor Supplies  | 7 Paints and Painting Supplies |
| 4 Grinding Supplies | 8 Miscellaneous Supplies       |

Numerous items may be included under each head. Thus the indirect factory materials and supplies specified for steel foundries by the Steel Founders' Society, Inc. (Uniform Accounting and Cost Plan) are as follows:

#### MANUFACTURING SUPPLIES

Molding Sand  
Lump  
Silica Sand Ground  
Flour  
Bentonite and Dextrine  
Molasses  
Core Oil  
Coke Breeze  
Sawdust  
Foundry Nails  
Chaplets  
Gaggers Rods Bar Iron and Steel  
Miscellaneous Manufacturing Expense Supplies

#### GENERAL STORES MATERIALS

Fuel Oil  
Coal, Coke and Charcoal  
Electrodes and Nipples  
Lumber (except Pattern)  
Sleeves and Tile  
Grinding Wheels  
Welding Carbon  
Welding Wire

#### GENERAL STORES MATERIALS (cost d)

Welding Gases  
Sand Blast Shot  
Roll Blasting  
Heat Treating Oil  
Fillet and Dowel Stock  
Paint  
Shellac Glue Putty  
Refractory Sand  
Shovels and Spades  
Bolts Nuts Washers Screws and Nails  
Hose and Hose Connections  
Sleeves Nozzles, and Stopper Heads  
Small Tools  
Shop Castings  
Boiler Compound  
Oils Greases and Gasoline  
Ties  
Fire Clay  
Chill Pieces  
Flask Clamps Bolts etc  
Miscellaneous General Stores Materials

**Indirect Labor Expense Accounts**—The indirect labor expense accounts recommended for steel foundries by the Steel Founders' Society, Inc. (Uniform Accounting and Cost Plan) are as follows:

Foremen and Assistants  
Clerks  
Furnace Helpers  
Furnace Chaiges  
Melters  
Shakeout Labor  
Cleaning Up Sand  
Flask Fitters  
Ladlemen and Helpers (Pouring from Shank Ladles)  
Gaggersmen  
Pattern and Core Carriers

Runner Cup Makers  
Tool Tenders  
Pouring Labor—Bull Ladles  
Core Pasters  
Oven Tenders—Core  
Plate Handlers  
Sand Delivery  
Oven Tenders  
Loading and Unloading Ovens  
Apprentices  
Process Inspection  
Departmental Trucking

Pattern Estimators	Chammen
Other Pattern Labor	Taking Inventory
Oven Fenders—Dry Mold Ovens	Core Castings
Jadle Repairing	Tumbling, Barical Labor
Sand Mixing—Milling and Reclaiming	Sand Blasting
Engineers	Salvage Welding
Electricians	Salvage Straightening—Fitters Operators
Watchmen and Janitors	General Labor
Fuel Drivers	Idle Time
Maintenance Inspection	Vacations and Sickness (Salaried Employees)
Cleaners	Allowances and Overtime Premiums
Making Gages and Templates	
Weighmen	

**Insurance Expense**—Insurance may be classified in detail as follows

Automobile Factory	Group
Boiler Explosion	Payroll Robbery
Compensation, Workmen	Raw Material Inventory
Elevator	Riot and Civil Commotion
Factory Building Fire	Formule
Factory Equipment Fire	Use and Occupancy

**Miscellaneous Factory Expense**—Miscellaneous factory expenses include a variety of expense items difficult or impossible to classify under other headings. Thus one electrical manufacturer includes under this heading the following:

- 1 Loss on short ends which cannot be charged directly to manufacturing orders
- 2 Analyzing and testing materials (including samples)
- 3 Unapplied demurrage
- 4 All necessary expenses due to travel of employees in connection with factory activities
- 5 Unassignable freight and express
- 6 Freight on patterns received from other works or outside foundries
- 7 Unassignable motor hauling by outside companies
- 8 Premium on employees' bond
- 9 Pay of employees on military duty
- 10 Suggestion awards
- 11 Court fees and other legal expenses including pay of witnesses and attorneys when they relate solely to manufacturing departments
- 12 Membership fees and expenses of manufacturing association
- 13 Meals for employees working overtime

In addition to numerous indirect labor, manufacturing supplies, and general stores accounts specified for use in steel foundries, the Uniform Accounting and Cost Plan mentioned above recommends the use of miscellaneous expense accounts as follows:

Provision for Refining Furnaces and Crucibles	Purchased Power
Production and Equipment Royalties	Water
Flasks	Gas
Loss on Defectives, Before Shipment	Drinking Water and Ice
Provision for Loss on Defectives After Shipment	Outside Trucking Expense
	License Fees
	Tire Expense
	Outside Physician's Expense
	Outside Hospital Expense

Ambulance Expense	Telephone
X Ray Expense	Telegraph
Goggles	Postage
Safety Signs	Printing and Stationery
Hospital Supplies	Outside Inspection
Welfare	Repairs Labor
Undistributed Weighing Charges	Repairs Material
Undistributed Freight	Repairs Miscellaneous Expense
Demurrage and Car Rental	Taxes on Buildings
Chemicals	Taxes on Equipment and Inventories
Engineering Fees	Depreciation on Buildings
Experimental or Development Expense	Depreciation on Equipment
Photostat and Blueprinting Paper	Insurance General on Buildings
Refuse Expense	Insurance General on Equipment and Inventories
Traveling and Entertainment	Insurance Employer's Liability
Automobile Expense	Insurance Group Life

**CONTROVERSIAL MANUFACTURING EXPENSES**—A divergence of opinion exists among accountants and managers in industry with respect to certain manufacturing expense items. The principal controversial items are as follows:

- 1 Administrative expense
- 2 Interest on plant investment
- 3 Depreciation on basis of reproduction cost value instead of on original cost basis
- 4 Taxes of various classifications

**General Administrative Expense**—Divisions of an industrial business are those which represent the principal functional activities, namely, manufacturing, marketing, administrative, and financial. To most cost accountants the only expenses to be reflected in the cost of production are those expenses incurred exclusively in connection with manufacturing activities. From a less orthodox cost accounting viewpoint a portion of general administrative expense is also included in manufacturing expense on the theory that the principal function of the general executive group is that of policy formulation for the entire business. The proportion of general administrative expense to be prorated to factory expense each month varies for each plant. The charge may be made in a number of different ways:

- 1 Use of some arbitrary percentage figure
- 2 It may be an amount based on a sliding scale related to productive output
- 3 It may be a uniform monthly percentage computed from a statistical analysis or study of the time devoted by the general executive group to plant policy
- 4 It may be prorated on the basis of the production and distribution costs

In this way after the total general administrative expenses have been accumulated for the month a proportionate amount is transferred by journal entry to Manufacturing Expense.

The chief argument against inclusion of general administrative expense in manufacturing expense is that such a practice tends to inflate the cost of production through the inflation of inventory values of work

in process finished goods, as well as cost of sales. The inflated cost of sales, in turn, results in a misstatement of profit for a given period.

**Interest on Investment**—The question of whether or not interest on investment is a proper charge to production cost has not been definitely settled, and must be answered by the management of each organization. Such imputed interest may be an important factor where large inventory values are tied up for long periods, as is the case in aging processes for tobacco inventories, bonded liquor, etc. The problem is well stated by Van Sickle (*Cost Accounting*):

The sanction lies in its economic interpretation. Just as rent is the return for the use of land and wages the return for the workman's labor, so interest is considered as the return for the use of capital. Included in the proponents of this argument are economists, engineers, plant managers, and owners who adhere to the economic interpretation of profits. 'Net profit' to them usually means pure profit which is the profit that is attributed to the compensation for the risk taken in carrying on a business enterprise.

The interest exclusionists are accountants, engineers, and business managers and owners who interpret net profit to mean the difference between revenue and the actual cost and expense of obtaining the revenue.

It is the contention that capital tied up in materials and other assets should return interest on capital before profit is determined. But interest on investment is not permitted as a deduction for federal income tax purposes. If it is included in cost and therefore in inventory on hand, it must be excluded in arriving at taxable income. Concerning interest on investment, the Cotton-Textile Institute Inc. (*A Method of Predetermining Costs in Cotton Yarn Mills*) has the following to say:

Believing that the continued operation of a manufacturing enterprise which persistently fails to return a normal current rate of interest on the investment is economically unsound, that an industry generally so situated could not hope to attract new capital and that investors are not justified in incurring the risks incident to the conduct of a manufacturing enterprise unless its returns exceed current interest rates, we have included in the overhead budget a charge for interest at 6% on the amount of capital normally required in the conduct of the business.

The details of the development of the interest charge consist of determining the value of the normal inventories of cotton stock in process, finished goods, supplies, cash, etc., which a conservative estimate would indicate as the minimum necessary for efficient conduct of the business. Interest at 6% is then computed on the principal amount thus established. All of this interest charge is distributed as an item of overhead except the interest on cotton inventory. The latter has been treated as a percentage to be added to the cotton waste factor. This procedure was followed in order to render this portion of the interest charge as flexible as the cotton price itself, as its amount normally depends upon the cotton price.

In general, accounting practice has gradually crystallized against the inclusion of imputed interest on the books. An interesting compromise is one offered by Van Sickle cited above who charges the interest and then proceeds to eliminate it again. A monthly journal entry is made as follows:

Overhead Expense (Interest on Plant Investment)	\$5 000 00	
Reserve for Interest on Plant Investment		\$5 000 00
To charge January operations with interest on plant investment of \$1 000 000 at the rate of 6% per annum		

The purpose of the reserve account is to act as a valuation account i.e., as an offset to overstated work in process and finished goods inventories. When the goods are sold the cost of sales is then adjusted through the reserve.

Assume overhead of \$30,000 excluding interest on investment, and of \$35,000 with interest included distributed as follow:

In Work in Process	\$ 1,071.43
In Finished Goods	7,142.86
In Cost of Sales	26,785.71
Total	<u>\$35,000.00</u>

The interest is then prorated to the above accounts on the following basis:

1. Work in Process Inventory

$$\frac{\$5,000}{\$25,000} \times \$1,071.43 = \$153.06$$

2. Finished Goods Inventory

$$\frac{\$5,000}{\$35,000} \times \$7,142.86 = 1,020.40$$

3. Cost of Goods Sold

$$\frac{\$5,000}{\$35,000} \times \$26,785.71 = \frac{3,826.54}{\$5,000.00}$$

Thus the sum of the first two items (\$1,173.46) is retained in the reserve while an adjusting entry is made to correct the profits reported at the end of the fiscal year:

Reserve for Interest on Plant Investment	\$3,826.54*	
Surplus		\$3,826.54*
To credit surplus with income imputed to the use of capital		

\*1 or the annual amount instead of this monthly amount

Comparative results are shown in Fig. 1. The difference in net profits represents the interest included in the cost of sales.

**Depreciation on Reproduction Cost**—Appraisal of plant property and equipment may disclose a "reproduction cost new" figure that is greater or less than an original cost basis. The result of adopting a reproduction cost base when it is above actual cost for computing depreciation is to overstate cost of production, work in process, and finished goods inventories as well as cost of sales and to understate the net profit for given period. If reproduction cost is less than the actual cost the accounts in which production costs are reflected are understated. An adjustment to correct inventory values and cost of sales is necessary in order to show an accurate profit. The adjustment is similar to that made in connection with interest on plant investment shown above.

**Taxes as Manufacturing Expense**—The controversy existing with respect to proper handling of taxes is described in a study compiled by the Research and Technical Service Department of the National Asso-

	CASE 1 Interest on Plant Investment Not Included in Cost		CASE 2 Interest on Plant Investment Included in Cost		Difference in Amounts
		\$120 000 00		\$120 000 00	
Sales					
Cost of Goods Sold					
Production Costs					
Direct Material	\$30 000 00		\$ 30 000 00		
Direct Labor	45 000 00		35 000 00		
Overhead Expense	30 000 00		35 000 00*		
Total Charges to Production during January 19__	\$95 000 00		\$100 000 00		\$5 000 00
Work in Process Inventory January 31 19__	4 846 94		5 000 00		153 06
Cost of Production January 19__	\$99 156 06		\$ 95 000 00		\$4 846 94
Finished Goods Inventory, January 31 19__	19 979 60		20 000 00		1 020 40
Cost of Goods Sold during January 19__		71 173 46		75 000 00	\$3 826 54
Gross Profit		\$ 48 826 54		\$ 45 000 00	
Marketing and Administrative Expenses		44 000 00		44 000 00	
Net Profit		\$ 4 826 54		\$ 1 000 00	\$ 3 826 54

\* Includes \$5 000 00 interest on plant investment

FIG 1 Comparative Statement of Profit and Loss

PER CENT OF COMPANIES RECEIVING AS								
Nature of Tax	Number of Companies	Deduction from Gross Sales	Increase in Raw Material Inventories	Increase in Manufacturing Costs	Increase in Administrative Expense	Increase in Selling Expense	Deducted from Net Profit Before Taxes	Other Treatment
Real Estate	486			85.0	10.5		3.1	13
Personal Property	456			70.2	16.2	3.8	3.3	1.1
Federal Income and Undistributed Profits	647			1.7	6.3		35.9	0.0
State Income	449	5		10.2	29.9	8.2	45.9	6.3
Foreign Income	113	3.5	9	9	19.3	3.3	67.0	12.4
Federal Capital Stock	648			10.2	63.7		21.3	4.0
Federal Excess Profits	460			1.7	11.4		82.0	4.0
State Capital Stock	324			11.4	59.9	11.4	13.0	3.4
State Franchise	504			10.1	63.3	9.3	15.9	3.2
Sale and Use	310	13.0	9.8	26.0	17.4	23.7	4.1	6.8
Customs Taxes and Duties	218	6.0	47.7	34.9	3.7	6.9		
Payroll Taxes	859			81.3	11.2		4.1	2.1
Direct Labor	953	6		81.0	11.9		4.2	2.2
Indirect Labor	945			5.6	21.9	53.9	7.1	2.3
Salesmen	643			13.0	79.5	8	4.2	2.3
Administrative	643			4.5	4.5	20.0	1.0	3.0
Gasoline Taxes	376	1.3	11.9	4.5	3.8	22.4	1.0	3.3
Motor Vehicle	479		2.6	61.1	3.8			
Excise Taxes								
Liquor and Beer	35	23.6	22.9	31.3	8.6		2.9	5.7
Tobacco	13	1.4	30.8	30.8	13.1		7.0	
Other	147	25.2	8.2	5.5	10.9	5.2	3.4	16.2
Taxes Paid at Source	51	9.0	9.8	19.0	2.5	2.0	17.6	23.5
Other Taxes	234		9	84.2	3.1	1.3	2.1	3.0

Fig. 2 Treatment of Taxes on Financial Statements

ciation of Cost Accountants. The study embodies data submitted by 750 members who supplied replies to a questionnaire. It indicated considerable variation in the treatment of various taxes in the account. A summary is shown in Fig 2 (N A C A Bulletin, vol 20).

Another investigation by the same authority covered factory payroll taxes only (N A C A Bulletin, vol 18). The consensus of opinion seems to be that payroll taxes whether on direct or indirect labor, represent additional labor cost. The following is a summary of the methods employed by the 260 organizations involved in this study:

- 1 22 concerns reported that payroll taxes were included in the basic labor rate as an element of direct labor cost.
- 2 20 companies reported the use of a fixed percentage applied to labor cost. Under this plan payroll taxes are treated as a kind of labor burden and are applied to jobs, processes, product lines etc. at a fixed per cent.
- 3 131 members reported that taxes on labor are included as an element of factory overhead.
- 4 76 members reported payroll taxes as being included in general or administrative expense.
- 5 10 members reported use of miscellaneous methods.

In recent years a controversy has been started concerning the propriety of including federal and state income taxes in the cost of production despite established theory that income taxes represent a sharing of profits with the government. The subject has been presented by Arisman (N A C A Bulletin, vol 19) as follows:

In order that earnings may be sufficient not only to meet the growing demands for taxes but in addition thereto to provide an adequate return to the stockholder and to further protect his interests by leaving an ample reserve in surplus to place the business on a sound economic basis it is proposed that income taxes both federal and state be included as an element of cost.

The same author refers to a study made by the National Industrial Conference Board published in their Bulletin (March 20 1931). The statistics gathered there cover reports on income from 89,085 manufacturing corporations. Arisman concludes:

that the return on invested capital to the stockholder and to business is too low and that some means should be taken to increase the earnings of the business. If income taxes were included in cost and secured from the consumer in the sales price, this would make a substantial contribution to the earnings.

The National Industrial Conference Board also points out the growing tendency of passing taxes on to the consumer through the establishment of sales taxes (Bulletin, July 10, 1935).

In addition to sales taxes, we have been confronted with processing taxes during the past few years. These taxes were passed on to the consumer in many cases because they were contained in the price of materials where one manufacturer created the materials and sold them to another who in turn further fabricated the product or article into a finished product for sale to the consumer. These processing taxes were included in costs and eventually found their way to the consumer in the sales price. It is believed that Social Security taxes are being included in costs and are contained in the total cost on which sales prices are set.



## Variable Manufacturing Expenses

**CHARACTERISTICS OF VARIABLE EXPENSES**—Manufacturing expenses are also classified according to degree of their variability. This classification discloses a threefold group of expenses as follows:

- 1 Variable expense items
- 2 Nonvariable expense items (fixed charges)
- 3 Partly variable expense items

A variable expense item is one whose total changes in proportion to changes in output. Doubling the output doubles the expense. There are very few expense items which are either 100% variable or 100% fixed. Note that variable expenses are those whose totals change. Expressed in terms of unit costs this type of expense shows constant costs, as illustrated in table shown below:

### VARIABLE EXPENSES RELATED TO UNIT COSTS

Production units	50 000	100 000
Total expense	\$50 000	\$100 000
Unit cost	\$1	\$1

A given variable expense item may have a higher degree of variability in some plants than in others, because of different degrees of control exercised by different manufacturing concerns, and also because of an increased rate of output. As productive output increases from one to

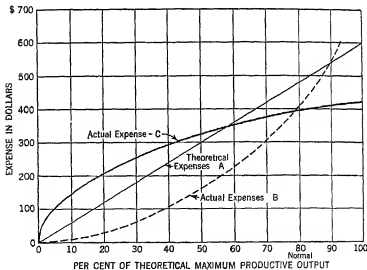


FIG 3 Types of Variable Expenses

two or three shifts a day, some variable expenses increase out of proportion to the increase in production.

**PLOTTING VARIABLE EXPENSE**—When charting variable expenses, different curves result, the shape of the curve depends on the degree of variability of the account in question. In Fig 3, line *A* represents a condition of 100% variability. Thus, at 25% of capacity, the expense is \$150, while at 50% of capacity the expense is \$300. The actual variation may be as shown in lines *B* or *C*. Line *B* shows a gradual acceleration of expense as output is stepped up, the slope of the curve becomes steeper. Line *C* shows a large change at first then tapers off with increasing output. In general, the slope, i.e., the steepness of the line, determines the degree of variability. As the slope increases the change in expense becomes more pronounced.

**EXAMPLES OF VARIABLE EXPENSES**—Among more commonly accepted variable manufacturing expenses are the following:

Compressed Air	Repairs
Defective Work Losses	Royalties
Demurrage	Spoilage
Fuel	Steam
Heat	Supplies Shop
Indirect Labor (hourly rate basis)	Supplies Factory Office
Insurance Workmen's Compensation	Taxes Social Security
Light	Telephone and Telegraph
Lubricants	Tools Small
Maintenance of Buildings, Machinery and Equipment	Transportation and Traveling Expenses
Power	Waste Disposal
Refrigerating Expense Furnace	Water

The salient features of some of these are discussed below.

**Compressed Air**—This item of manufacturing expense usually varies with a high degree of uniformity with variations in output. The reason may be that compressed air is not allowed to blow off unrestrictedly. When not needed, it is turned off. When charted, the curve of compressed air costs appears irregular. This is due to leakage in tanks and pipe lines when compressed air is not in use.

**Demurrage**—This is a variable expense item that arises in connection with the failure to unload carloads of raw materials within a required time limit allowed by the railroad company. It is an item of expense that is incurred when business activity comes close to or exceeds the point of normal operating activity. It resembles line *B* in Fig 3. As business activity increases, carload shipments greatly increase and the storehouse unloading labor gang often falls behind in its work.

**Fuel**—This covers such items as coal, gas, oil, coke, wood and charcoal. The expense incurred for these items varies uniformly with output except for fuel used in producing steam for generating power. The fuel expense in this latter instance usually varies with the number of pounds of steam produced.

**Heat**—This expense item shows twofold variability:

- 1 Seasonal variance
- 2 Variance related to productive output

The seasonal variance is more pronounced. In moderate climates no building heat expense is incurred during the summer months. During the winter months this item is at its peak, the smaller amounts being incurred during the fall and spring months. A decline in productive output has only a limited effect on the steam heat expense; the curve for which may be in the form of a horizontal line indicating a nonvariable expense. The charting of this item is more complicated than it is for almost any other expense item, because of its twofold variability. Heat expense for each month of the year may be charted in order to estimate total annual heat expense. This total expense is divided by 12 in order to ascertain the average monthly amount to be charged uniformly to each month's operating expense. This is the normal or standard burden plan. If actual monthly heat expense is shown graphically, the curve varies in accordance with the mean average temperature of each month and the percentage of productive activity.

Where a plant generates its own electric power, steam heat is usually provided from boilers in the powerhouse. Even if power is not generated, steam may be produced for heating purposes exclusively. A production cost sheet must be provided for the total monthly steam cost per 1,000 pounds of steam produced. A portion of the steam cost measured by meter is charged at the monthly unit cost per 1,000 pounds to Steam Heat Expense. The remainder of the steam produced is transferred to another cost sheet used to assemble the cost of generating electric power.

**Indirect Labor**—In some cases this type of expense tends to vary most uniformly with productive output. In others such as foremen's or other supervisory compensation the expense is fairly constant.

**Workmen's Compensation Insurance**—This item may or may not include the amount applicable to direct labor. However, workmen's compensation insurance applicable to indirect labor payroll, as well as direct labor where it is charged as overhead, varies almost uniformly with productive output.

**Light**—Light is sometimes included as an item in a composite expense account called Building Occupancy. If light expense is handled as a separate item of expense, it varies roughly with productive output, like curve *C* in Fig. 3. The reason for this is that some public utility companies offer a sliding scale rate structure to industrial consumers. With increased kilowatt-hour consumption there is a decreased rate per 1,000 kilowatt-hours consumed. Where an industrial concern produces its own power, the unit cost of a thousand kilowatt-hours tends to decrease with increased output and vice versa, because of the effect on nonvariable expense reflected in the cost of production.

**Water**—Water is required both for production in many plants and for drinking and cleaning purposes in all plants. Ceramic factories, glass plants, and steel mills all require large quantities of water in connection with their productive operations. Except where water constitutes part of the raw material content of the product it is to be considered as manufacturing expense, roughly varying with output.

**Power**—Power varies with productive activity similar to light expense (line *C*, Fig. 3), especially where a sliding scale rate structure is

offered by the local utility. Where an industrial concern generates its own electric power, it must produce its own steam. The steam used to generate electric energy is meter-measured in order to ascertain its cost based on the kilowatt-hour generated, and the cost per kilowatt hour. This cost in turn is transferred at the unit cost price to the departments consuming the power.

## Nonvariable Manufacturing Expenses

**FIXED CHARGES**—Nonvariable expenses are commonly referred to as fixed charges. Few manufacturing expenses are 100% fixed. A fixed charge is defined as one whose total remains constant or whose total does not change with changes in output within the limits of plant capacity. When reduced to a unit cost basis, however, such charges vary as shown in the illustration below.

### FIXED CHARGES RELATED TO UNIT COSTS

Production units	50 000	60 000
Fixed charges	\$30 000	\$30 000
Unit cost	\$ .60	\$ .50

When plotted, fixed charges are indicated by a horizontal line. This type of expense items is becoming constantly more important because of increasing use of expensive automatic machinery in modern production. Underlying the idea of mass production is the desire to decrease unit costs by increasing production.

Fixed charges may also be defined as those representing a constant sum for a given accounting or fiscal period, by contrast variable charges represent a constant sum per unit of product. Thus **straight-line depreciation** in effect charges a fixed amount per month or year. On the other hand the **service output method** of depreciation charges a given amount per unit. In the former case, depreciation is a fixed charge; in the latter, a variable charge.

**EXAMPLES OF FIXED CHARGES**—Examples of nonvariable manufacturing expenses are:

General Administrative Expense	Amortization
Depreciation	Licenses
Dues, Factory Employee Association	Medical Fees
Insurance	Patents Amortization
Interest on Plant Investment	Replacement of Equipment Amortization
Inventory Losses from Obsolete Materials Scrapped	Rent
Inventory Shrinkage from Theft	Repairs
Waste, etc.	Subscriptions
Leased Property Improvements	Factory Periodicals
	Taxes

Some of these are briefly described below.

**General Administrative Expense**—The amount transferred from month to month to Manufacturing Expense may be a lump sum and, if so, amount represents a constant charge. If the amount transferred is a percentage of total general administrative expense, it is likely to fluctuate from month to month. This is due to the fact that some variable items are included in the group account Administrative Expense.

**Depreciation**—Depreciation is a fixed charge when its calculation yields a uniformly equal monthly charge, this is the case under straight line or fixed percentage of cost method. The fixed percentage of diminishing value method of computing depreciation gives a decreasing annual depreciation charge, but each year's charge is divided by 12 and thus produces a constant monthly depreciation expense. Depreciation can, however, be converted into a variable charge by changing the basis of computation. If depreciation is computed by the working hours method, the production or service output method or the mileage operated method (in case of factory automobiles), amount of this expense item varies proportionately with productive activity.

**Factory Employee Association Dues**—This item is also classified as fixed. It represents dues paid by the company for its employees. As the expenditure is incurred it is charged to a Prepaid Dues account. Through monthly adjusting entries the expense is spread evenly over the months to which the dues apply.

**Insurance**—Expenditures for insurance premiums for all types of coverage, except workmen's compensation, are charged to a Prepaid Insurance account. Details of policies are recorded in an insurance register. These data provide the basis for ascertaining the monthly expense proportion, which thus becomes a fixed monthly charge.

**Inventory Losses**—Inventory losses that arise from raw materials scrapped or obsolete are accounted for usually in one of two ways.

1 Raw materials inventory loss is sometimes shown as an end-of-the-year adjustment through Profit and Loss. In following this practice the charge does not affect manufacturing expenses. Consequently, an adjustment made in this manner is not reflected in the cost of production.

2 A better accounting treatment is to include this loss in Manufacturing Expense, in order that it, in turn, may be reflected in the cost of production. Past experience provides a basis for estimating the loss from this source. The estimated annual raw material inventory loss from scrapped and obsolete pieces of material is anticipated at the beginning of the fiscal year. Equal monthly charges based upon the annual estimate are then made through adjusting entries, hence, this expense becomes a nonvariable item.

**Inventory Shrinkage**—Shrinkages occur in raw materials for a number of reasons. Some materials are pilfered or stolen, some are lost through sweeping and cleaning, some are taken from storeroom stock without a proper stores requisition, etc. This type of loss may be accounted for as an end-of-the-year adjustment but monthly production costs are more accurate if the loss from this source is estimated and accounted for by monthly adjustments. Regardless of the reason, shrinkage should be anticipated and reflected as an item of expense in the cost of production. The annual total is approximated from an average of prior years' inventory adjustments. The estimated loss is then divided by 12 to provide the monthly nonvariable expense for inventory shrinkage.

**Amortization of Leased Property Improvements**—This is a nonvariable expense because the expenditure is capitalized and then amor-

tized in equal annual and monthly instalments over the periods that receive the benefit from this expenditure

**Licenses**—Plant automobile licenses, boiler licenses, plant building elevator licenses, etc., are expenditures charged to prepaid accounts. In turn they are reduced to manufacturing expenses and prorated evenly over the periods of time to which they apply

**Medical Fees**—This expense item falls under nonvariable classification when an outside physician is paid a fixed monthly fee to provide physical examinations and medical attention covering injuries to plant employees

**Patents Amortization**—Patents are capitalized at acquisition. The capitalized cost is spread in equal annual and monthly instalments over a 17-year period, or in a shorter period of time if obsolescence is anticipated or foreseen. The equal monthly charges constitute nonvariable expenses. If patent is amortized on a production basis, it becomes, of course, a variable expense

**Rearrangement of Equipment**—The expense involved in rearranging machinery and equipment in a plant is a proper item to capitalize, because the benefit received from the rearrangement is reflected in increased future production. The number of years over which the benefit accrues is the basis for prorating the capitalized expense. In some industries, e.g. the automobile industry, each change of models involves a rearrangement of equipment, the expense for which is charged off during the model year. If equal amounts are written off monthly, the charge is fixed; if the amortization is based on production, the charge of course is variable

**Rent**—Rental expense for plant buildings and equipment constitutes a current monthly expenditure of uniform amount. Hence rent is a nonvariable expense item

**Repairs**—This expense is classified as fixed when annual repair expense is estimated at the beginning of a fiscal year, and then prorated in equal monthly charges. This accounting procedure is often followed in connection with building repairs, and with repairs to heavy equipment that is infrequently overhauled. Under this plan, the uniform monthly expense charge is offset by credits to an account, Reserve for Nonrecurring Building (or Equipment) Expense. As occasional building repairs are made they are charged against the Reserve for Nonrecurring Building Expense. In this way the repair charges are stabilized and actual building repairs made infrequently but in large amounts are prevented from distorting the total plant expense, as would be the case if they were treated as variable expenses

**Subscriptions to Factory Periodicals**—This item is capitalized in a prepaid expense account if it represents a substantial amount. The capitalized expense is reduced to a nonvariable expense item by equal annual and monthly expense charges

**Taxes**—Plant property taxes paid in advance are treated as a prepaid expense, and prorated in equal monthly instalments for the year to which they apply. In the event that plant property taxes are ac-

cured the monthly accrual charges are equal and thus also result in a nonvariable expense item.

For other examples of fixed charges see account classification of the Electrical Manufacturing Industry, earlier in this Section.

### Partially Variable Manufacturing Expenses

**CHARACTERISTICS OF PARTIALLY VARIABLE MANUFACTURING EXPENSES**—A partially variable or semi-variable manufacturing expense item is one that varies with production within certain limits and remains constant at some stages of productive output. Such items increase in amount as production increases but the increase is not uniform in the case of variable expenses. Actually a semi-variable expense item increases in incremental steps as production increases from the shutdown point to the theoretical maximum output point (Fig. 4).

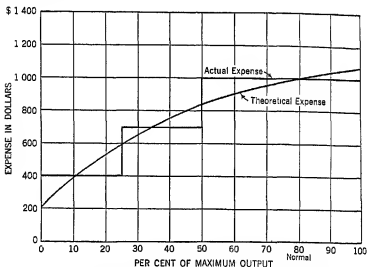


FIG. 4 Foremen Expense in Relation to Productive Output

A policy usually adhered to by management at the shutdown point is to keep a nucleus of the departmental executives. To discharge the key factory executives results in a disruption of production when factory operations are resumed. As production activity increases, however, the volume of production requires greater supervision. Consequently, some additional clerks, stenographers, and assistant foremen are hired. This brings about the first increase in semi-variable indirect labor expense. With still further increases in output, more increases occur in indirect labor expense, until the maximum amount is reached.

These different aspects of a semi-variable expense item are graphically portrayed in Fig. 4, in the case of salaries of foremen. The chart shows a fixed expense of \$400 for any level of production from 0 to 25% of capacity. At that point a sudden increase takes place, probably the hiring of an assistant foreman. The expense then becomes constant at \$700 until the output reaches 50% of capacity. Another increase then takes place and the expense again becomes fixed this time at \$1000. The exact allowances are usually smoothed out by drawing a curved line through the mid-points of each incremental step, as shown in Fig. 4.

**COMPARISON OF SEMI-VARIABLE AND VARIABLE EXPENSES**—When plotted, variable expense items may indicate a convex curve as in Fig. 3 (curve C) for such expense items as heat, light, and power. Semi-variable expense items, likewise, may indicate a convex curve when the successive steps of increased expense are smoothed out as in Fig. 4. There is thus a similarity between curves for the two types of expenses. However, a true variable expense disappears when the output falls to zero (Fig. 3, curve C). In the case of a partially variable item, some expense element remains even at the shutdown point (Fig. 4). The reason for smoothing out the incremental steps is that the smoothed curve provides theoretical expense amounts at each percentage point of productive output. These amounts are necessary when a flexible expense budget is used in conjunction with a standard cost system.

Examples of semi-variable expenses are the various expense accounts for indirect labor paid on a monthly salary basis instead of an hourly rate basis. These include such classifications as factory office clerks, foremen, heads of service departments, cost accountants, engineers, pyrometers, purchasing agent, storekeeper, welfare manager, shop superintendent, factory office stenographers and the works manager.

**IMPORTANCE OF CLASSIFYING EXPENSES ACCORDING TO BEHAVIOR**—An understanding of the behavior of manufacturing expenses is essential in connection with

- 1 Control of such expenses
- 2 Computation of predetermined burden rates
- 3 Construction of manufacturing expense budget
- 4 Effect on unit cost of production

From the viewpoint of control, variable expenses are the most easily controlled, while nonvariable manufacturing expenses are least susceptible to control.

Predetermined burden rates should be developed to show the components in terms of variable and nonvariable expense items. This is particularly necessary if under- and overabsorbed burden are to be analyzed to show the amount applicable to variable expenses (controllable variances) and the amount applicable to nonvariable expenses (volume variances).

In preparing factory expense budgets, the expenses incorporated therein are arranged in groups according to their degree of variability. The budget, in turn, is one of the principal factors in the preparation of predetermined burden rates, in the control of expenses, and in the development of differential cost analyses.

Different types of expenses exert different effects upon unit costs of production. The general tendency of all variable expense items is to



increase in amount more or less proportionately to the productive output. It necessarily follows that the unit variable expense tends to remain fairly constant. The total nonvariable expense remains constant irrespective of the volume of output. Thus, unit nonvariable expenses tend to fluctuate. Fig 5 illustrates the tendency of unit costs to decrease with increasing production.

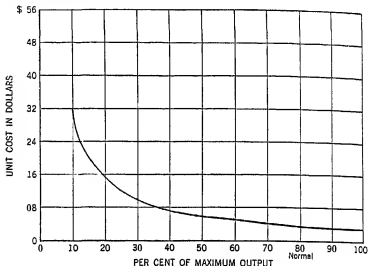


FIG 5 Relation Between Volume of Output and Unit Depreciation Costs

**RELATION BETWEEN SEMI VARIABLE EXPENSES AND COST OF PRODUCTION**—Semi-variable expense items remain constant between certain percentage intervals of productive output, and then increase sharply. The following illustration shows the effect of foremen's salaries on unit production costs, the same data are presented graphically in Fig 6.

Capacity	Direct Labor Hours (000's)	Foremen's Salaries	Cost per Direct Labor Hour
0%	0	\$ 4 800	
10	30	4 800	\$ 16
20	60	4 800	08
30	90	8 400	0933
40	120	8 400	07
50	150	8 400	056
60	180	12 000	0667
70	210	12 000	0571
80 (normal)	240	12 000	05
90	270	12 000	044
100 (max)	300	12 000	04

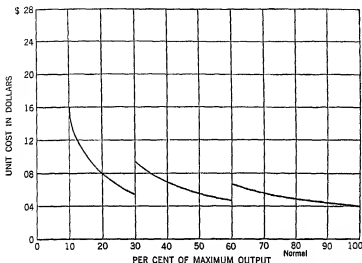


FIG. 8 Relation Between Volume of Output and Unit Costs for Foremen's Salaries

## Departmental Manufacturing Expenses

**PURPOSE OF DEPARTMENTALIZATION**—A manufacturing plant is laid out along departmental lines primarily for production purposes, in order to

- 1 Secure, i.e. basically different processes of production
- 2 Secure the smoothest possible flow of production
- 3 Establish lines of responsibility for physical control over production

A cost accounting system is designed to fit in with departmentalization from this physical plant viewpoint. This makes possible the accumulation of production costs for operations carried on within each department, either on a job or process basis.

**MANUFACTURING OR PRODUCING DEPARTMENTS**—In general, a manufacturing department is one in which manual and machine operations are performed directly upon any part of the commodities produced. These departments are also referred to as producing or productive departments. More specifically, productive departments are those whose costs may be charged to the product because they have contributed directly to its production. Note that it is not necessary that the product actually pass through a department for it to be classified as productive. As an illustration, the coremaking department of a foundry is considered a productive department although castings are not worked

on in this department. Ability to charge cost-making costs to individual jobs or classes of products justifies its classification as a productive department.

**SERVICE DEPARTMENTS**—Service departments are those not directly engaged in production, but which render particular types of service for the benefit of other departments. In some instances the services furnished benefit other service departments as well as the manufacturing departments. Note that commodities and jobs manufactured do not pass through service departments. But the expense incurred in the operation of service departments represents a part of the total manufacturing expense that must eventually be absorbed in the product.

**ANALYSIS OF DEPARTMENTAL EXPENSES**—A twofold analysis of all factory expenses, by objects of their expenditure, and by departments (producing and service) to which the expenses apply, is a requisite cost accounting procedure. The following objectives are thus attained:

1 It segregates factory service expenses, and provides a total for each service department which is necessary before a service department expense distribution can be made properly to manufacturing departments.

2 It segregates manufacturing department expenses applicable directly to the producing departments and service department expenses applicable indirectly to producing departments. This procedure is necessary since it forms a basis for determining expense rates to be applied to the product.

3 It makes possible the establishment of controls to keep expenses at a minimum.

The Steel Founders' Society of America, Inc. recommends that for the purpose of cost allocation to product groups, the following four types of departments be recognized (Uniform Accounting and Cost Plan for Steel Foundries):

- |                                  |                         |
|----------------------------------|-------------------------|
| 1 Direct Productive Departments  | 3 Auxiliary Departments |
| 2 General Productive Departments | 4 Service Departments   |

These four types of departments are described as follows:

1 **Direct Productive Departments**—These include for each product group the following departments corresponding to processes or operations:

- |                 |                          |
|-----------------|--------------------------|
| a Melted Metals | d Cleaning and Finishing |
| b Molding       | e Heat Treating          |
| c Core          |                          |

2 **General Productive Departments**—These comprise those productive departments or operations having elements of cost which cannot be directly applied to the direct productive departments by product groups. For example, one furnace may serve for two or more product divisions.

Accordingly, it is necessary to accumulate the conversion expense in one account and distribute the total at the close of the period to the several direct productive departments which it serves. In this group are the following:

- |                      |                        |
|----------------------|------------------------|
| Pattern Shop         | Core Making Green Sand |
| Open Hearth Furnaces | Cleaning and Finishing |
| Electric Furnaces    | Routine Heat Treating  |
| Alloy Furnaces       | Special Heat Treating  |
| Core Making Dry Sand |                        |

3 **Auxiliary Departments**—These departments correspond to the general productive departments excepting that they cover the nonproductive manufacturing operations of departments rather than the productive. In this group are the following

- |                   |                       |
|-------------------|-----------------------|
| a Dry Sand Mill   | d Dry Sand Mold Ovens |
| b Green Sand Mill | e Ladles              |
| c Core Sand Mill  |                       |

4 **Service Departments**—Service departments represent those nonproductive operations or departments which unlike the auxiliary departments are also nonmanufacturing. The proposed list of service departments is as follows

- |  |  |
|--|--|
| Z-1 Power and Light Purchased                    | Z-18 Laboratory  |
| Z-2 Power Plant                                  | Z-19 Purchasing Department                                   |
| Z-3 Heating Department                           | Z-20 Receiving and General Stores                            |
| Z-4 Floor Space Rental Office Building           | Z-21 Locomotive Cranes                                       |
| Z-5 Floor Space Rental Foundry Buildings—Group A | Z-22 Receiving and Storage—Metals and Manufacturing Supplies |
| Z-6 Floor Space Rental Foundry Buildings—Group B | Z-23 General Engineering                                     |
| Z-10 Drivage and Trailing                        | Z-24 Repair and Maintenance Department                       |
| Z-11 Works Management                            | Z-25 Pattern Storage   |
| Z-12 General Superintendence                     | Z-26 Fuel Oil Storage  |
| Z-13 Production Planning                         | Z-27 Traveling and Wall Cranes                               |
| Z-14 Payroll Department                          | Z-28 Inspection Department                                   |
| Z-15 Cost Department                             | Z-29 Compressor Department                                   |
| Z-16 Employment and Welfare Department           | Z-30 Waste Sand, and Refuse Disposal                         |
| Z-17 Safety and Dispensary                       |  |

In contrast with the above detailed classifications of departments is the classification suggested in the Manual of Job Cost Finding Practice for Miscellaneous Jobbing Steel Foundries, by the same Steel Founders' Society of America, Inc.

The foundry is departmentalized for job cost foundry purposes in the following manner

- 1 Productive Departments
  - a Melted Metal
  - b Molding
  - c Core
  - d Cleaning
- 2 Service Departments
  - a Pattern Storage
  - b Routine Casting Inspection
  - c Routine Heat Treating
  - d Shipping
- 3 Works Burden All other manufacturing expense which is not charged to any of the eight departments mentioned above

**Examples of Producing Departments**—Names of manufacturing departments depend on the nature of the industry and the type of work performed. In a plate glass factory, the manufacturing departments are mixing, melting, polishing and grinding, wareroom-uncut stock, and wareroom order cutting.

The manufacturing departments in a cement mill are stone crushing

raw grinding and mixing, coal crushing and pulverizing, kiln burning and cooling, finish grinding and storing, and packing and loading.

A machine-tool manufacturing concern has manufacturing departments as follows: forging, annealing, heat treating, pattern making, core making, molding, melting, chipping and cleaning, machine shop, fitting and erecting.

A steel axle mill has manufacturing departments known as rolling, annealing, shearing, trimming, grinding, tumbling, pickling, and testing.

A china manufacturing company has manufacturing departments called clay mixing, kiln, decorating and packing and shipping.

A coal mine has the following departments, comparable to manufacturing departments: mining, hoisting, crushing, screening, washing, and loading.

Departments usually found in a metal working plant (N. A. C. A. Bulletin, vol. 15) are

1 Purchasing	8 Polishing
2 Receiving	9 Milling Machines
3 Stores	10 Gear Cutting and Key Setting
4 Sheet Metal Plant	11 Drilling and Horizontal Millers
5 Forge Shop	12 Grinding
6 Planers	13 Special Tools
7 Turlet Lathes	14 Toolroom
8 Engine Lathes and Vertical	15 Assembly
9 Millers	16 Painting
10 Screw Machines	

**Subdividing Productive Departments**—In many cases for cost application purposes direct departments are subdivided to form cost centers. Where two or more different types of work are performed in the same department, such subdivision increases the accuracy of overhead rates and product costs. As an illustration of such a detailed breakdown the departments and cost centers listed below are suggested in the Manual of the Uniform Cost Finding System for Bookbinders.

1 Flat Sheet Cutter	21 Line Up Machine
2 Quad Folder	22 Board Cutter
3 2/32 Folders	23 Cloth Slitter
4 2/16 Folders	24 Smythe Case Makers
5 Jobber Folders	25 Sheridan Case Maker
6 Cleveland Folders	26 Case Mailing, Hand
7 Girls' Miscellaneous Handwork	27 Gold Laying
8 Hand Pasting	28 Hot Press Stamper
9 Machine Pasting	29 Inkers
10 Stripping Machine	30 Casing In Hand
11 Singer Sewers	31 Casing In Machine
12 Gathering Machine	32 Examine and Map
13 Smythe Sewers	33 Repair Department
14 Smashers	34 Packing and Boxing
15 Nipper	35 Shipping and Delivery
16 Trimmer	36 Flat Sheet Handling
17 Gilding and Edging	37 Folded, Gathered, or Sewed
18 Glue Up for Backs	Stock Handling
19 Rounding and Backing	38 Bound Book Stock Handling
20 Line Up Hand	

**SERVICE DEPARTMENTS ILLUSTRATED**—Names of service departments vary with the nature of concern and the nature of service rendered. Some service departments are common to all indus-

trial concerns, as for example, storeroom service, factory cost accounting service factory timekeeping, and payroll service. Small plants may have only four or five plant service departments. As the size and scope of the plant increase an expansion of service departments occurs to the point where a single company may have many service departments. Thus, a typical list might be as follows (N A C A Bulletin, vol 15)

1 Steam Plant	9 Laboratory
2 Power Plant	10 First Aid
3 Building Expense	11 Employment
4 Shop Maintenance	12 Production Planning
5 Engineering	13 Cost and Payroll
6 Drafting	14 Tool Storage
7 Inspection	15 General Administration
8 Testing	16 General Building

The following classification is presented from the Uniform Accounting Manual of the Rubber Manufacturers' Association

#### Nonproductive Departmental Overhead Accounts

Industrial Relations	Experimental and Development
Employment Department	Department (machine and product development)
Medical Department	Test Car Department
Welfare Department	Technical Service Department
Police Department	Specification Department
Fire Department	Transportation and Service
Safety and Sanitation Department	Garage Department
Cafeteria Department	Central Trucking Department
Power	General Yard Department
Boiler Plant Department	Shop Departments
Electrical Generation Department	Mold and Core Department
Electrical Transmission Department	Machine Shop and Maintenance Department
Compressed Air Department	Toolroom Department
Hydraulic Power Department	Electrical Maintenance Department
High Pressure Service Water Department	Drafting Department
Low Pressure Service Water Department	Clerical
Gas Department	Timekeeping Department
Drinking Water System Department	Payroll Department
Stores	Cost Department (including engineering costs and property records)
Purchasing Department	Factory Accounting Department
Receiving Department	Time Study Department
Stores Department	Production Planning Department
Salvage Department	Scheduling Department
Laboratory and Development	Finished Product
General Research Laboratories	Shipping Department
Chemical Testing Department	Finished Goods Warehouse Department
Physical Testing Department	General Factory Expense
Fabric Testing Department	

The names of these departments vary from plant to plant. They may be further subdivided or several of the above may be combined in one. Thus some plants have but one maintenance department while others have separate shops such as

- |                      |                   |
|----------------------|-------------------|
| 1 Blacksmith Repair  | 4 Electric Repair |
| 2 Building Occupancy | 5 Machine Repair  |
| 3 Carpenter Repair   |                   |

### CONTENT OF DEPARTMENTAL EXPENSE ACCOUNTS

—For effective control of departmental operations, it is necessary to subdivide the total expense of a department so as to localize excessive costs. To this end, the primary expense accounts are broken up and allocated to departmental accounts. Hence, a good many expense accounts are common to all departments. For example, office supplies, indirect labor, supervision, clerical, maintenance etc., are to be found to a greater or lesser degree in all departments. This calls in effect for two ledgers subsidiary to the same controlling account. The Manufacturing Expense account controls the primary expense or manufacturing expense ledger. The accounts in the latter are then distributed to the departments either in a departmental expense ledger or on an expense distribution sheet. A few service departments and their account content are presented below.

**Factory Accounting**—Factory accounting department performs functions with respect to factory expense and cost transactions as follows:

- 1 Assembles original records containing cost data pertaining to raw materials, direct labor, and overhead costs
- 2 Sorts these cost data
- 3 Journalizes and posts cost data
- 4 Analyzes cost data by cost elements, departments, operations, orders, products and jobs
- 5 Synthesizes cost data as called for by company executives
- 6 Prepares cost reports
- 7 Computes work in process inventory values
- 8 Computes unit costs, finished goods inventory values and costs of sales for commodities and jobs

Variable expenses of factory accounting are factory office supplies, stationery and printing, light, power, heat, maintenance and repairs of equipment, social security taxes, and workmen's compensation insurance. Nonvariable expenses are tabulating machine rentals for tabulating equipment located in cost department, depreciation and property insurance on company owned equipment, and depreciation and property taxes and insurance on building space occupied by the cost accounting department. Semi-variable expense is for salaries of cost accountants and clerks.

**Payroll Department**—The factory payroll department handles time tickets for all manufacturing and service departments, and in so doing performs the following functions:

- 1 Recording daily hours worked or daily earnings upon payroll
- 2 Entering individual employees' rates on time tickets or payroll sheet
- 3 Verifying accuracy of employees' daily earnings by application of internal control procedure
- 4 Computing individual employee deductions
- 5 Calculating individual employees' earnings
- 6 Preparing pay checks or pay envelopes
- 7 Maintaining individual employees' earnings and hours worked records
- 8 Paying employees

Variable expenses of the payroll department are for office supplies and printed forms, electric current heat, wages paid to employees on an hourly rate basis, social security taxes, workmen's compensation insurance, and payroll robbery insurance.

Nonvariable expenses of payroll department are for depreciation and property insurance on departmental equipment and for a proportionate share of the building fixed charges based upon the relative amount of space occupied by department.

Semi-variable expense of this service department is for salaries paid to paymaster and other departmental salaried employees.

**Powerhouse**—The boiler room produces steam, which is used for generating electric current compressing air, heating buildings, air conditioning buildings, and for manufacturing purposes. Steam produced in boilers, in turn, is an expense to other subdivisions of powerhouse service as follows:

1 Steam required for generating electric current is meter-measured in order to ascertain the fuel expense for producing current. The number of thousands of pounds of steam passing through the meter provides a basis for fuel expense. The current generated is carried to lighting lines and to power lines. Lighting lines furnish building and yard light service, while power lines provide current for running motors which operate machines and other equipment. Power is also used for testing electrical equipment and apparatus in the process of manufacture.

2 Steam used for producing compressed air is also measured by meter in order to determine the fuel expense required to produce the compressed air. The latter is used in many different ways for manufacturing purposes.

3 For building heat purposes, there are two different methods of obtaining heat from the powerhouse:

- a Where hot water and exhaust steam are used for heating purposes it is difficult to establish the cost to be charged to building space heated. An engineering study is required to arrive at a fair and accurate cost after taking into consideration all variable factors.
- b Where pressure steam is used for heating purposes meters measure the consumption of steam used for heating purposes.

4 Where air conditioning is required for manufacturing purposes the steam is used to heat the air before it is distributed by forced blast, and refrigeration equipment is used to cool the air before it is distributed. If humidification of air is required, water is passed over it. The total cost of air conditioning includes:

- |                               |                  |
|-------------------------------|------------------|
| a Steam                       | e Power for fans |
| b Water for humidifying       | f Attendance     |
| c Refrigeration if any        | g Maintenance    |
| d Oil for dust screens if any |                  |

5 Steam required for manufacturing processes is measured by meter before it enters the main feed line to the manufacturing departments.

In the production of steam, variable expenses incurred are boiler fuel, sundry supplies, small tools, water, air, power, light, equipment repairs and maintenance wages social security taxes, and workmen's compensation insurance. Nonvariable expenses are charges for depreciation and



liability insurance on equipment, and depreciation, insurance, and property taxes on the building that houses the boiler room equipment. Semi-variable expenses are salaries paid to the powerhouse engineers and attendants.

In the generation of electric current, the variable expenses are steam, gas, air, heat water, power, light, small tools, maintenance and repairs on the equipment, wages, social security taxes, and workmen's compensation insurance. Nonvariable and semi-variable expenses are similar to those for the powerhouse enumerated in the preceding paragraph.

In the compression of air the variable expenses are steam, sundry supplies, repairs on and maintenance of equipment, power, light, wages, social security taxes and workmen's compensation insurance. Nonvariable and semi-variable expenses are similar to those enumerated above.

In transferring hot water or steam to buildings for heating purposes, as well as steam for manufacturing purposes, transmission lines are usually included as part of the cost of the powerhouse steam plant equipment. Pipes and radiators are included as cost of the respective buildings where they are located.

In providing air conditioning the variable expenses are steam, power, water, dust screens, sundry supplies, small tools, maintenance of and repairs on fans, maintenance of humidification and refrigeration equipment, wages, social security taxes and workmen's compensation insurance. Nonvariable and semi-variable expenses are similar to those enumerated above.

**Toolroom Service**—The toolroom in many industrial concerns performs a threefold service:

- 1 Issuing and checking return of expensive hand tools that are kept in custody of toolroom when not in use. This is generally known as tool crib service.
- 2 Aiding in carrying on development and research work.
- 3 Making tools and dies for factory use.

The accounting problems in connection with toolroom service are analyzed in an article by Papenfoth (N. A. C. A. Bulletin vol 22). According to this authority, toolroom department overhead includes three groups of charges:

- 1 Direct charges including supervision, clerical labor, maintenance, etc.
- 2 Fixed charges.
- 3 Prorated general expenses including a share of general factory supervision, and a share of all costs of operating the general factory departments such as cost accounting, purchasing, building, etc.

Papenfoth goes on to say:

In discussing tool costs we are not alone concerned with the initial expenditure for making tools but also their subsequent maintenance. The cost of maintaining tools in the toolroom or a subdivision thereof may be accumulated by job orders if desirable or at least charged to manufacturing departments making use of the tools. It seems only reasonable, when charging manufacturing departments for maintenance work performed by the toolroom, that such charges should absorb and include as a part of this maintenance cost, the regular toolroom overhead.

Variable expenses of the toolroom are miscellaneous factory supplies, small tools, light, power, heat, compressed air, maintenance and repairs.

on equipment, wages, social security taxes and workmen's compensation insurance, as well as prorated general expenses. Nonvariable expenses are depreciation and property insurance on departmental equipment and depreciation and property taxes and insurance on the portion of the plant building required for the toolroom. Semi-variable expense of this department is for salaries paid to the foreman and assistants.

**DIRECT AND INDIRECT CHARGES**—All expenses incurred in the operation of departments are charged to their respective group or departmental accounts. These expenses may be further subdivided into

- 1 Direct departmental expenses
- 2 Indirect departmental expenses

The classification of manufacturing expenses as direct and indirect applies to producing as well as service departments. The terms direct and indirect have different meanings in connection with cost elements. Raw material and direct labor are referred to as direct costs of the product since these costs can in the first instance be identified with product.

Manufacturing expense represents an indirect cost of the product since it must be charged to the product on the basis of some estimate. In connection with manufacturing expenses, the terms direct and indirect refer to departmental classifications.

Direct expenses are those charges which in the first instance can be identified with a particular department. Indirect expenses represent service department charges prorated from other departments, thus, all indirect expenses are direct charges to service departments, and when redistributed become indirect charges to the producing departments.

### Accumulating Plant Expenses—Manual Records

**STEPS IN ACCOUNTING FOR MANUFACTURING EXPENSE**—The following steps are involved in accounting for manufacturing expense

- 1 Analyzing the expense transactions
- 2 Entering the expense transactions on original records and summary sheets
- 3 Journalizing the expense transactions
- 4 Posting expense transactions to subsidiary expense ledgers
- 5 Posting the expense transactions to the Manufacturing Expense control account
- 6 Proving the balance in the subsidiary ledger against the control account and tracing it through to the expense distribution sheet at the end of each month
- 7 Spreading the totals of direct charges over all departments affected thereby
- 8 Distributing service department expenses to other departments as indirect charges
- 9 Applying expenses to products

**METHODS FOR ACCUMULATING MANUFACTURING EXPENSES**—No uniform plan is followed by industrial concerns. While it is true that there is a general pattern or routine procedure to be followed in expense accumulation there are many ways of accomplishing it. Two basic plans for expense accumulation are recognized.

- 1 Use of handwritten records
- 2 Use of accounting machines

There are, however, many cost systems in operation which utilize a combination of handwritten records and machine accounting with respect to plant expenses. In addition the design of the accounting system must provide a specific way for the accumulation of overhead in the general ledger or factory ledger. There are two plans which may be followed:

- 1 Expenses are all accumulated in a single Manufacturing Expense control account
- 2 Manufacturing expenses are segregated in separate departmental expense accounts

Under the first plan, journal entries accumulate manufacturing expense transactions and post them to the single control account. Underlying this account may be a departmental expense ledger or an expense distribution sheet showing the distribution of the departmental primary expense charges. Under the second plan, journal entries accumulate expense transactions and post them to separate departmental expense accounts, and thus simultaneously provide primary expense distribution among producing and service departments.

**ANALYZING PLANT EXPENSES**—Those responsible for analyzing manufacturing expense transactions are also responsible for classifying and segregating them into their proper plant expense accounts. In a small industrial concern one cost clerk may be sufficient for this work. In the medium-sized and larger manufacturing plants, a subdivision of the factory accounting activities designates different persons as being responsible for analyzing different overhead transactions. For example, current monthly expense charges such as royalties, rent, medical fees, small tool purchases, etc., are transactions common to one group. They are analyzed and classified by account code and name through a purchase voucher clerk. End-of-the-month expense adjustments for depreciation and amortization of fixed and deferred assets are similarly treated by another cost clerk. Another clerk handles indirect labor. In a similar manner other expenses are analyzed, classified, and made ready for recording by other cost clerks.

To secure accurate expense accumulation proper analysis of expenses must be made at their inception. Those charged with this duty must be thoroughly familiar with names and code numbers of each expense account and also with the function of each account. They must refer to the accounting manual if necessary.

**CODE SYSTEMS FOR MANUFACTURING EXPENSES**—An account code system is a combination of figures, or letters, or both, which accompanies the name of an account. Codes employing numerals only are found in most general use. When an overhead expense code is used, the account number is placed on the original record or journal entry at the time the transaction is analyzed and recorded. The code number established at that time insures proper posting. (For detailed discussion of coding and symbols, see Section 3.)

**RECORDING MANUFACTURING EXPENSES**—Where expense controls are used, the books of original entry must be designed to





remittance part of the purchase voucher check (For detailed discussion of purchase transactions, see Section 5)

**Petty Cash Vouchers**—Occasionally factory expense transactions are recorded on petty cash vouchers. These transactions are for small amounts covering such expenses as carfare, emergency taxicab fare, and miscellaneous factory expense items.

**Stores Requisitions**—These cover charges made for expense items drawn from the stores and supplies inventory. Foremen and factory departmental heads and assistants are designated as the responsible persons to write requisitions. Such requisitions should specify the account, code number, and department to which the expense applies (Fig 8).

When an extensive departmental and subaccount chart of expense accounts is used, it is preferable to employ expense requisitions that contain only one item, the reason lies in the fact that several items might affect several account numbers, both as to debits and credits.

Expense accounts commonly affected by transactions involving stores requisitions are such items as fuel, lubricants, miscellaneous factory supplies, refractory materials, repair materials, shop office supplies, and small tools.

**Time Tickets**—Time tickets are used for time worked by indirect laborers paid on an hourly rate basis. The timekeeper or workmen must be instructed to indicate on the daily time tickets pertinent data so that the proper factory expense accounts are charged for then time. These data include the indirect labor occupation name and code number or the expense code number, and the department to which indirect labor applies (Fig 9).

EMPLOYEE'S NAME										DEPT NO	EMP NO
PART NO					OPER NO					CHARGE DEPT	
DESCRIPTION OF WORK										CHARGE ORDER OR ACCT	
-----										FOREMAN	PIECES
SPECIAL ORDERS FOR INDIRECT LABOR	START	FIN.	START	FIN.	START	FIN.	EARN INCS	HOURS	RATE	AMOUNT	M CO FORM SHOP 37
							BONUS				
							TOTAL				

FIG 9 Indirect Labor Time Ticket

**Repair Orders**—Factory expense transactions pertaining to maintenance work are recorded on special service repair orders. This form is illustrated in Fig 10. Possible expense accounts affected by transactions recorded on maintenance and repair orders are

- |                                       |                                  |
|---------------------------------------|----------------------------------|
| 1 Maintenance of Factory Auto mobiles | 5 Maintenance of Machinery       |
| 2 Maintenance of Factory Building     | 6 Maintenance of Railroad Siding |
| 3 Maintenance of Factory Equipment    | 7 Maintenance of Roadways        |
| 4 Maintenance of Factory Grounds      | 8 Repairs of Building            |
|                                       | 9 Repairs of Equipment           |
|                                       | 10 Repairs of Machinery          |

EXPENSE ORDER			
DATE _____ 19__		EXPENSE ORDER NO. _____	
DEPT. OR DIVISION	DESCRIPTION		CHARGE ACCOUNT NO.
SEARCHED BY _____			
EST. M.	D. C. T.	MA. RIA	L. E. C.
SEL. VER. TO _____		QUOTE. Y _____	APPRO. ED BY _____
D. T. E. WANTS _____			

FIG 10 Service Repair and Maintenance Order

**SUMMARY RECORDS FOR RECORDING MANUFACTURING EXPENSES**—The chief summary records used to record factory expenses are

- 1 Service department cost reports
- 2 Factory building and equipment ledger
- 3 Patents ledger
- 4 Engineering department computation records
- 5 Indirect labor distribution sheet
- 6 Insurance register
- 7 Authority for expenditure orders
- 8 Cost department accumulation records

**Service Department Cost Summary**—Service department unit costs must be obtained in order to distribute the service expense to other departments. Hence, a cost summary is prepared each month. Fig 11 shows such a cost summary for compressed air produced. The steam, labor, and service expenses required to produce compressed air each





month are accumulated on a report of this type. Unit cost per 1,000 cubic feet of compressed air are then computed and shown on the summary.

Similar service department cost summaries are prepared for steam produced, electric power generated, water pumped and treated, and switching service rendered. The engineering department provides quantitative data, while the cost department supplies the expense figures.

**Plant Ledger**—The factory equipment ledger is a subsidiary ledger that provides details supporting fixed asset control accounts for Plant Buildings, Machinery and Equipment, and other tangible fixed assets subject to depreciation. The ledger is usually designed in loose-leaf form for use in binders, or as a card for file drawers, or as a tabulating card. The principal items to be provided for on the equipment record are factors which record the original cost of the asset and the depreciation applicable thereto. The reverse side of the ledger card usually provides space for a repair and maintenance record.

Original cost of equipment includes the invoice price, transportation and handling charges, materials and labor costs incurred in its installation, and any other costs prior to placing the machine in operation. The total cost less scrap value, becomes the basis for computing the annual depreciation charge. The latter is divided by 12 to provide the monthly depreciation expense. In practice the scrap value is often disregarded. The totals of monthly depreciation figures for machinery and equipment are accumulated on cost department summary records to form the basis for an end of the month depreciation adjusting journal entry. From a similar work sheet analysis of monthly building depreciation expense, a monthly journal entry is prepared.

The columnar headings on these summary work sheets provide for complete information concerning each unit or group.

1 Number	5 Depreciation Rate Annual
2 Name	Amount, Monthly Amount
3 Date Acquired	6 Accrued in Depreciation Reserve
4 Estimated Life	7 Undepreciated Cost

Separate columns are sometimes provided for each month, since there may be some additions to or deletions from, the list of depreciable assets from time to time which cause changes in the monthly depreciation charges. In practice, however, the monthly columns are usually found unnecessary. To speed up monthly statements, month-end adjustments are reduced so far as possible to a fixed routine. For depreciation an average amount is charged monthly with a final adjustment made at the end of the year based on the exact figures revealed by the plant ledger. In order to provide complete control over depreciation expense by groups of plant property and equipment, one manufacturer employs a summary of the cost of each group of fixed asset accounts (Fig 12) and also a summary of depreciation by groups (Fig 13).

**Patents Ledger**—The patents ledger is a subsidiary ledger in which are kept all details necessary to account properly for each patent. As a patent is capitalized in the general ledger account, an auxiliary record is prepared for the patents ledger (Fig 14). Monthly patents amortization expense on each patent as obtained from patents ledger is accumu-

## REAL ESTATE, PLANT AND EQUIPMENT

Account Number	Description	Balance End of Previous Month	Add. this Month	Less Deductions this Month	As per Balance Sheet	Total as of Month End	Amount or Difference	Balance End of Current Month	Total as of Month End	
									Debit	Credit
32	Land Improvements									
33	Land									
34	Land and Improvements									
35	Buildings									
36	Buildings and Equipment									
37	Buildings and Equipment									
38	Buildings and Equipment									
39	Buildings and Equipment									
40	Buildings and Equipment									
41	Buildings and Equipment									
42	Buildings and Equipment									
43	Buildings and Equipment									
44	Buildings and Equipment									
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92	Buildings and Equipment									
93	Buildings and Equipment									
94	Buildings and Equipment									
95	Buildings and Equipment									
96	Buildings and Equipment									
97	Buildings and Equipment									
98	Buildings and Equipment									
99	Buildings and Equipment									
100	Buildings and Equipment									

Amount by company and employee and other as shown in company account  
 (2) Accepted by company and other as shown in company account

FIG 12 Plant Ledger Summary

SUMMARY OF DEPRECIATION—BY CLASS AND QUANTITY									
Account number	Description	Amount at end of prior month	Current month—This year			net carrying amount at end of month	net carrying amount at end of prior month	Amount of depreciation charged	Balance at end of current month
			Depreciation charged—this month	Other amounts	cash				
201	Real Estate								
202	Buildings								
203	Land								
204	Improvements on land								
205	Leases								
206	Other								
207	Equipment								
208	Tools and fixtures								
209	Transportation								
210	Communication								
211	Other								
212	Intangible								
213	Goodwill								
214	Patents								
215	Copyrights								
216	Trademarks								
217	Other								
218	Other								
219	Other								
220	Other								
221	Other								
222	Other								
223	Other								
224	Other								
225	Other								
226	Other								
227	Other								
228	Other								
229	Other								
230	Other								
231	Other								
232	Other								
233	Other								
234	Other								
235	Other								
236	Other								
237	Other								
238	Other								
239	Other								
240	Other								
241	Other								
242	Other								
243	Other								
244	Other								
245	Other								
246	Other								
247	Other								
248	Other								
249	Other								
250	Other								
251	Other								
252	Other								
253	Other								
254	Other								
255	Other								
256	Other								
257	Other								
258	Other								
259	Other								
260	Other								
261	Other								
262	Other								
263	Other								
264	Other								
265	Other								
266	Other								
267	Other								
268	Other								
269	Other								
270	Other								
271	Other								
272	Other								
273	Other								
274	Other								
275	Other								
276	Other								
277	Other								
278	Other								
279	Other								
280	Other								
281	Other								
282	Other								
283	Other								
284	Other								
285	Other								
286	Other								
287	Other								
288	Other								
289	Other								
290	Other								
291	Other								
292	Other								
293	Other								
294	Other								
295	Other								
296	Other								
297	Other								
298	Other								
299	Other								
300	Other								

Depreciation by property and—equal year—equal to value—equal

2. Amount by accounts and other subject to similar accounts

Fig 13 Summary of Depreciation and Reserve for Depreciation

listed on a work sheet, similar to that used to summarize depreciation charges

Patent Number _____		Department in which used _____	
Description of Patent _____			
Date Acquired _____		Original Cost _____	
Period of Amortization _____		Annual Amortization _____	
		Monthly Amortization _____	

Date	Cost	AMORTIZATION		Date	Cost	AMORTIZATION	
		Annual	Accumulated			Annual	Accumulated

FIG 14 Patents Ledger Record

**Engineering Department Data**—In some concerns, the engineering department computes certain expense data for the cost department. For example, the number of kilowatt-hours of electric power consumed in each department is a computation usually prepared by the engineering department. The monthly lighting expense also may be computed by the engineering department and submitted to the cost department where the end-of-the-month adjusting entry is prepared. Compressed air consumed, steam used, and maintenance reports of work done in different departments are additional data accumulated by the engineering department for subsequent use in the cost department.

**Indirect Labor Distribution Sheet**—Indirect labor time tickets may be summarized each month on a distribution sheet similar to one shown on Fig 15. This summary record provides for an accumulation of indirect labor expense classified by departments and by occupations within departments; it also provides data from which the end-of-the-month adjusting entry is made to distribute the portion of factory payroll relating to indirect labor.

**Insurance Register**—An insurance register is necessary to provide a detailed record of each policy, to show the monthly write-off of prepaid insurance to expense, and to establish the expense distribution to the several divisions of the business. The form illustrated (Fig 16) provides all this information conveniently. Each group of policies relating to the same type of insurance coverage may be listed on a separate page,

or, where there are not many policies, blocks of five or ten lines may be assigned to each group. In this way each page or each block on a page refers to a specific expense account, and a separate analysis is not necessary. The right half of the register provides space for a complete month-by-month record of write offs and a final summary of total expired and total unexpired insurance at the end of the year. The sum of the last two items should, of course, equal the sum of the new insurance purchases and the total brought forward from the prior year. This provides a valuable check on the accuracy of the detailed computations.

LABOR DISTRIBUTION											
Department No. _____					Account _____						
Month				Year		Month				Year	
D a y	Daily		To date		D a y	Daily		To date			
	Hrs	Amount	Hrs	Amount		Hrs	Amount	Hrs	Amount		
1					1						
2					2						
3					3						
4					4						
5					5						
6					6						
25					25						
26					26						
27					27						
28					28						
29					29						
30					30						
31					31						
Remarks _____											

FIG. 15 Indirect Labor Distribution Sheet

In the example shown (Fig. 16) further analysis is usually necessary. Thus, the charge to Insurance on Building and Equipment may be subdivided into separate charges for insurance relating to the powerhouse, stores buildings, factory office etc. Similarly, for insurance on equipment, accounts may be set up for insurance on machinery, machine tools, factory furniture and fixtures, etc.

**Authority for Expenditure Orders**—In many plants arbitrary limits are set on the amount of money that may be expended exclusive of

current production requirements, without procuring an executive order. Any amount expended below the limit set for example \$50 or \$100, is treated as a revenue charge and no authority is required for such expenditures. Any amount to be expended above the arbitrary limit set must be approved upon a form known as an appropriation request (See section 21 on Research and Development Cost). When this is approved a capital order number is given to the appropriation. Costs of all materials, labor and factory and service expenses applicable to such order are accumulated by cost department. Upon the completion of the project the accumulated cost is capitalized in the proper account. By subsequent monthly adjusting entries, the capitalized cost is transferred to proper plant expense accounts.

**EXPENSE SUMMARIES ACCUMULATED BY COST DEPARTMENT**—There are several summary records prepared by the cost department for the purpose of providing figures for monthly journal entries. They are summaries of

- 1 Depreciation expense
- 2 Property insurance expense
- 3 Patents amortization expense
- 4 Machinery rearrangement expense
- 5 Power expense
- 6 Light expense
- 7 Heat expense
- 8 Workmen's compensation insurance expense
- 9 Social security tax expense
- 10 Property tax expense

The monthly totals for these expense items are obtained from the sources mentioned earlier. Worksheet summaries form the basis for the journal entries. After plant expenses are recorded on original and summary records, they are next entered in one of following books of original entry.

- 1 Voucher register
- 2 General journal
- 3 Factory journal

The form of books of original entry depends on the basic plan for the accumulation of plant expenses in the control account. If there is only one expense control, a single column only need be provided in the voucher register and other books of original entry in which expenses are recorded. Where departmental expense controls are used, there should be as many columns provided in the voucher register and other books of original entry as there are control accounts.

**Voucher Register**—After factory expense transactions are entered on purchase vouchers, showing code number and the name of the overhead expense account, they are next entered in the voucher register. The effect of these entries is to build up charges posted to Manufacturing Expense at the end of each month. Purchase vouchers prepared preliminary to the entry of amounts in the voucher register show the distribution of charges. Fig 17 for voucher 1007 is typical of such vouchers.







Postings are made as follows

- 1 The total of the voucher (\$1 919 24) is included in the voucher register column total posted to account 500 Manufacturing Expense (Fig 19)
- 2 Subaccount 502 Small Tools is debited in the manufacturing expense ledger (Fig 20) for the total of the voucher
- 3 The departmental expense distributions shown on the purchase voucher provide the necessary analysis for posting to detailed accounts contained in a departmental expense ledger or on an expense distribution sheet (see Section 18)

VOUCHER			
In favor of <u>The National Tool Company</u>		No <u>1007</u>	
		Date <u>January 2, 19__</u>	
DISTRIBUTION			
Debit 502 Small Tools		Credit	
Department 00	\$ 589 27		
Department 01	642 87		
Department 02	81 07		
Department 03	401 63		
Department 04	83 96		
Department 05	5 04		
Department 06	10 50		
Account 500 Manufacturing Expense	\$1 919 24	Account 201 Accounts Payable	\$1 919 24

FIG 17 Purchase Voucher showing Account Distribution

**General Journal**—The majority of manufacturing expense transactions are accumulated through the general journal or journal vouchers. The general journal is either in bound or loose leaf form and contains a special column for Manufacturing Expense. Factory expense transactions entered in this column permit the accumulation of a total which is posted at end of the month to the control account.

A journal voucher (Fig 18) may be used in lieu of a general journal. A single journal entry is placed on each journal voucher sheet, from which a posting is made to the appropriate ledger accounts. The journal vouchers are then filed away and become the general journal record. Expense transactions for which journal entries are made on journal vouchers are principally end-of-the-month factory overhead adjustments. Transactions entered on journal vouchers are for:

- 1 Shop supplies small tools fuel lubricants repair materials and factory office supplies withdrawn from storeroom on stores requisitions
- 2 Charges to indirect labor expense accounts taken from indirect labor distribution summary



- 3 Spoilage expenses obtained from defective work tickets
- 4 Maintenance and repair charges prepared from repair orders
- 5 Power light heat and water (when purchased from public utility companies) expenses amounts are obtained from engineering and cost department computations
- 6 Depreciation charges obtained from plant equipment ledger records and depreciation analysis work sheet records
- 7 Property insurance and tax expenses taken from work sheet analyses
- 8 Patents amortization expense obtained from work sheet analyses
- 9 Social Security tax expenses taken from work sheet analyses
- 10 Workmen's compensation insurance expense obtained from work sheet analyses

For some factory expense transactions no write-up is made prior to their entry on a journal voucher. They are formulated and recorded as soon as they occur. Under such circumstances the journal voucher may show the computations which provide the figures for the entry. Examples of this type of transaction are for

- 1 Transfer of a portion of administrative expense to Manufacturing Expense
- 2 Inventory losses from obsolete materials scrapped
- 3 Inventory shrinkage from theft waste and action of the elements based on past experience data

Fig. 18 shows a typical journal voucher. The debit total is posted to Manufacturing Expense (Fig. 19). Postings are also made to the manufacturing expense ledger (Fig. 20). Fig. 18 may be adapted for use where standard costs are employed by providing columns for amounts at standard and actual, and variance.

The supporting evidence for the journal entry appearing on each journal voucher is represented by a variety of forms, the most common of which are

- 1 Adding machine tapes which list figures taken from original or summary records
- 2 Engineers' reports
- 3 Cost department work sheet analyses

**Factory Journal**—Where the cost system provides for cost accounts to be kept in a separate factory ledger, a factory journal is required at the factory cost office. In such a case, all expense transactions entered in the general journal or on general journal vouchers involving factory cost accounts must also be entered in the factory journal or on factory journal vouchers.

### LEDGER POSTING OF MANUFACTURING EXPENSES—

The ledgers affected by postings of manufacturing expenses are

- 1 General ledger or factory ledger
- 2 Manufacturing expense ledger

**General Factory Ledger**—The Manufacturing Expense control (Fig. 19) account is located in either the general ledger or factory ledger. Where a single control account is used, factory overhead transactions

are posted to that account. Under this plan, detailed primary expense items are then posted in the manufacturing expense ledger. Under this procedure the transaction does not have to be analyzed with respect to departmental expense accounts affected. Detailed allocations to different departments are made on a monthly expense distribution sheet from supporting evidences attached to the purchase vouchers and to journal vouchers (see Section 18).

#### 500 MANUFACTURING EXPENSE (control)

19—			
Jan 31	V1	\$ 6 550 24	
31	JV1	2 668 65	
31	JV2	386 00	
31	JV3	807 64	
31	JV4	2 401 80	
31	JV5	20 000 00	
31	JV6	4 160 80	
31	JV7	4 076 00	
31	JV8	420 00	
31	JV9	25 129 14	
31	JV10	1 494 00	
31	JV11	1 475 00	
31	JV12	723 33	
31	JV13	433 33	
		<u>\$77 611 71</u>	

FIG 10 Manufacturing Expense Control Account

**Manufacturing Expense Ledger.**—Where a single expense control account is used the subsidiary expense ledger contains one account for each primary factory expense item. These accounts accumulate factory expenses classified according to the object of their expenditure for all manufacturing and service departments. The form of the expense ledger under this plan follows one of two customary plans. It may be either the conventional ledger ruling, or in the form of an expense analysis sheet (Fig. 20).

Where departmental factory expense control accounts are used, a separate subsidiary expense ledger or analysis sheet is provided for each control account (Figs. 21 and 22). Each analysis sheet has a full classification of variable, nonvariable and semi-variable expense accounts to record the factory expenses applicable to each department.

In Fig. 21 the expenses pertaining to the engineering department are accumulated in account 01, Engineering Expense (control). Postings to this account are made from the same records and books used to describe the expense accumulation and the posting to a single expense control account. The sources of the postings are indicated in the figures to the left of each posting.

The arrangement of expense accounts in the subsidiary ledger should be such that it facilitates posting. To this end the following points should be observed:

1. Accounts should be arranged in separate groups classified as variable, nonvariable and semi-variable.

## MANUFACTURING EXPENSE LEDGER

FOR JANUARY 19\_\_

501 FACTORY SUPPLIES		502 SMALL TOOLS	
JV1	\$2 083 65	V 1007	\$1 919 24
503 FACTORY OFFICE SUPPLIES		504 FUEL	
V 1010	\$ 280 79	V 1011	\$3 050 00
505 WATER		506 DEFECTIVE WORK JOURNAL	
JV2	\$ 336 00	JV3	\$ 802 64
507 REPAIR MATERIAL EQUIPMENT		508 REPAIR LABOR EQUIPMENT	
JV4	\$9 481 80	JV6	\$4 500 00
509 MISCELLANEOUS FACTORY SUPPLIES		510 WORKMEN'S COMPENSATION INSURANCE	
V1008	\$ 400 21	JV6	\$4 148 85
511 SOCIAL SECURITY TAXES		512 MATERIAL HANDLERS	
JV7	\$4 075 60	JV5	\$2 400 00
513 HELPERS		514 SERVICE ATTENDANTS	
JV9	\$3 200 00	JV5	\$4 240 00
515 FOREMEN		516 DEPARTMENTAL HEADS AND ASSISTANTS	
JV9	\$5 100 00	JV9	\$2 450 00
517 FACTORY OFFICE CLERKS		517 MEDICAL SERVICES	
JV5	\$4 100 00	V 1030	\$ 300 00
518 PATENTS AMORTIZATION		518 DEPRECIATION BUILDINGS	
JV8	\$ 420 00	JV9	\$2 950 00
519 DEPRECIATION EQUIPMENT		519 INSURANCE BUILDING	
JV9	\$22 870 18	JV10	\$ 147 00
520 INSURANCE EQUIPMENT		520 TAXES BUILDING	
JV10	\$1 262 00	JV11	\$1 475 00
521 MAINTENANCE BUILDING		521 RELIANCE EXPENSE	
JV12	\$ 223 33	JV13	\$ 433 33

FIG 20 Manufacturing Expense Ledger

2 Each group should be given a distinctive code number. The first digit of the code number for a subsidiary expense account is the same as the first digit in the control account number. The second, third, and fourth digits, if the latter are necessary, are so arranged as to distinguish clearly variable and semi variable items.

3 Code numbers should be so arranged as to provide for expansion of each group of factory expense accounts, classified by their degree of variability.

**PROOF AND DISPOSITION OF BALANCES IN FACTORY EXPENSE ACCOUNTS**—Each month the Manufacturing Expense control account as well as the balances of accounts in the subsidiary expense ledger must be brought into agreement by proving the control balance against the aggregate of balances in the subsidiary ledger. In case of disagreement, the reason for differences must be ascertained and the error or errors corrected.

#### 01 ENGINEERING EXPENSE (control)

19--			
Jun 5	Factory Office Supplies	V1010 \$	127 80
31	Miscellaneous Factory Expenses	V1008	22 13
31	Workmen's Compensation Insurance	JV10	78 50
31	Social Security Taxes	JV7	102 00
31	Dept. Salaries	JV5	1 000 00
31	Factory Clerks	JV5	1 500 00
31	Depreciation Buildings	JV10	120 00
31	Depreciation Equipment	JV9	166 67
31	Insurance Equipment	JV10	6 00
31	Insurance Building	JV10	8 00
31	Truck Building	JV11	80 00
31	Repairs and Maintenance Buildings	JV12	40 00
			<u>\$3 300 00</u>

FIG. 21 Engineering Expense Control Account

Where a single expense control is used, the balances in the subsidiary ledger, after proof of correctness, are transferred to an expense distribution sheet. The latter shows the factory expense account names and code numbers arranged in the same sequence as in the expense ledger. This uniformity of order of arrangement makes for the greatest possible ease in transferring the account balances from the subsidiary ledger to the distribution sheet. The detailed procedure followed in preparing expense distribution sheet is described in Section 13.

Where departmental control accounts are used to accumulate expenses, the balances in control accounts are most likely closed monthly to Work in Process. Each departmental expense sheet discloses an analysis of its operating expenses. In the case of service departments the distribution of the total on each department ledger sheet is made at the bottom of the sheet. These ledger analyses are then filed away for subsequent review and reference.

ABSTRACT OF EXPENSE													
#11 Department						Month of							
SUPT & CLERKS		MISC GENERAL EXPENSE		INS & TAXES		ASSESS GENERAL				SUPTS & CLERKS STAMP		MISC EXP STAMP	
DEPREC STAMP				MISC EXP LAMIN		DEPREC LAMIN		ASSESS ALLOY				OFFICE	
COMMER ALLOY		GENERAL COMMER		COMMI S ROYALTY STAMP		COMMISS ROYALTY LAMIN		COMMISS & ROYALTY RIVETS					
<div style="text-align: right;"> Total Gen Bill  Total Office  Total Commercial  TOTAL </div>													

FIG 22 Manufacturing Expense Ledger Sheet for Use with Departmental Expense Control Accounts

### Accumulating Plant Expenses—Mechanical Records

**USE OF MECHANICAL APPLIANCES**—Machines used in the preparation of machine-written records may be either bookkeeping and accounting machines or punched card accounting machines. There is a wide variety of bookkeeping and accounting machines as well as punched card accounting machines which are utilized in the accumulation of plant expenses for the purpose of

- 1 Preparing entries in the voucher register
- 2 Preparing entries in journal vouchers
- 3 Mailing postnotes to factory expense accounts in the expense ledger
- 4 Mailing expense analyses by accounts and departments

**EXPENSE ACCUMULATION ON TABULATING MACHINES**—The punched card is the sole original record used in conjunction with tabulating machines. While the cards are uniform in size they can be designed in many forms to fit specific needs in accumulating plant expenses. These cards are designed in two basic styles:

1 A tabulating card which provides no spaces for handwriting. It is designed in fields or zones (containing varying numbers of columns of digits totaling 80 columns in all), which provide spaces for punching holes that represent the data to be accounted for. Holes are punched in tabulating cards from handwritten original records.

2 The tabulating card may be a dual card. It provides spaces for writing the original data or transaction on the card itself, in addition to the 80 columns used for punching handwritten data therein. The dual card thus eliminates the necessity for preparation of some other preliminary original record. Holes in dual cards are punched from information written on the card.

Some tabulating cards most frequently used to record data in the accumulation of expenses are as follows:

Type of Tabulating Card	Type of Factory Expenses Accumulated
1 Accounts payable expense distribution	Purchase of items which are charged directly to expense, instead of being charged to inventory
2 Stores requisition	Indirect materials and supplies, small tools, etc., withdrawn from storeroom
3 Time ticket	Indirect labor of all classifications
4 Defective work report	Defective work and spoilage losses incurred
5 Maintenance and repair order	Maintenance and repair costs
6 Factory building and equipment ledger	Monthly depreciation charges for each unit of equipment
7 Insurance expense	Insurance expenses applicable to each month's operation

**JOURNAL ENTRIES IN CONJUNCTION WITH TABULATING MACHINES**—After cards are punched, they are run through an electric sorting machine. For journal entry purposes, the cards are sorted in chronological order. When all cards are sorted, the totals are obtained by running the sorted cards through a tabulating machine.

An example of this performance is the sorting of all accounts payable cards punched during the month involving expense items. The cards are sorted by code numbers which designate producing and service departments. After sorting by departmental code numbers, they are re-sorted by expense account numbers in accordance with the authorized expense classification. Next, the cards are placed in the accounting tab-



ulating machine which tabulates and summarizes expense amounts applicable to each producing and service department. From this summary a journal voucher may be prepared as follows:

Manufacturing Expense (control)	\$	
Accounts Payable		\$
For purchase of expense items according to tabulating list attached		

Details shown on the summary are so arranged as to furnish a complete expense analysis.

**ILLUSTRATION OF MECHANICAL EXPENSE TABULATION**—The following description is adapted from Meyers (Outline of Some Specific Industrial Accounting Procedures by Electric Tabulation).

**Indirect Labor and Material**—The original record for indirect labor is a tabulating card designed specifically for:

- 1 Recording basic information regarding labor cost incurred
- 2 Computation and preparation of payroll
- 3 Accounting distributions
- 4 Statistical reports

Fig. 23 shows such a card, filled in by a workman. When it reaches the industrial accounting department, the information appearing on the card is punched according to "fields" outlined on the bottom of the card. When this has been verified, the cards are matched and multiplied with master rate cards containing the employee's hourly rate to produce the actual labor cost. This forms the basis for the preparation of the following:

- 1 Payroll
  - a The cards for a complete payroll period are summarized by clock numbers; special cards are interspersed for tax, insurance deductions, etc.; pay check and payroll summaries are prepared mechanically from summary cards.
  - b Information returns as required by federal and state governments are also prepared mechanically from the summary cards.
- 2 Payroll accounting entries
- 3 Statistical reports such as the accumulation of information used in the following:
  - a Statement of hours and labor cost by departments
  - b Departmental expense statements, budgets, etc.

Delivery of material from the storeroom is authorized by a material requisition card which is handled in a manner similar to the handling of the indirect labor cards.

**Expense Accumulation and Distribution**—Distribution cards (Fig. 24) are not summarized by accounts for posting in the expense ledger, but each card makes an individual entry in the expense ledger. The latter is prepared each month for each department showing totals by individual expense classifications (Fig. 25). These ledgers are prepared mechanically on tabulating equipment. Beginning with a balance for the previous month all the entries affecting a particular account are sorted together, tabulated, and a new balance created. The listing of these transactions is the expense ledger. As can be seen in Fig. 25, this type





CO DIV	ACCOUNT			MEMORANDUM	REFERENCE				SOURCE		
	CONTROL	SUB	ITEM		CON NO REC-TER NUMBER	DATE	DATE	DATE	DATE	NUMBER OF VET	DATE
12	8302	29	10		12399	02	20	0	AP 01	39550	0
12	8302	29	20		12399	02	20	0	AP 01	39550	0
12	8302	29	21		12399	02	20	0	AP 01	39550	0
12	8302	29	21		12176	02	11	0	AP 01	10550	0
12	8302	31	01		8354	99	01	0	11 01	20405	0

AMOUNT			%
STANDARD	VARIANCE	ACTUAL	
876		876	
396		396	
2246		2246	
3706		3706	
3706		3706	
3405		3405	
1405		1405	

FIG 25 Manufacturing Expense Ledger Prepared from Tabulating Cards

of expense ledger shows detail which is invaluable in analyzing expenses. Entries marked "AP" are Accounts Payable items and show both the vendor's number and register number of individual invoice supporting the charge. The "IJ" or Industrial Journal source of entry is supported by detail cards making up the summary, e.g., indirect labor time tick, etc., "JV" entries are those supported directly by the General Journal or Journal Voucher.

Expense redistributions, i.e., prorating of auxiliary department expense to producing departments, etc., are computed by means of a work sheet and incorporated in monthly journals, thus affecting the expense ledger. All redistributions from a particular department are included in one expense account under that department's ledger (coded 99). Similarly, all redistributions to a particular department are included in one expense account under that department's ledger (coded 96). This method of holding redistributions of manufacturing expense within specific accounts allows for easy mechanical elimination of these redistributions for statistical and tax purposes.

# SECTION 18

## OVERHEAD DISTRIBUTION

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Factory supplies	964	Factory accounting service	983
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Tool expense	964	Flotang labor service	984
General factory expense	965	General plant service	984
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## SECTION 18

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### OVERHEAD DISTRIBUTION

#### Bases for Primary Distribution

**PRIMARY EXPENSE DISTRIBUTION**—The first stage in accounting for manufacturing expenses is then accumulation, the second involves the identification of such expenses with departmental standing orders, i.e., departmental expense accounts. This is a primary expense distribution which may be defined as the apportioning of manufacturing expenses over the producing and service departments to which they apply. Such expenses are in the nature of direct departmental charges. The principal purpose of the primary expense distribution is to charge different producing and service departments with the proper amounts of variable, semi-variable and nonvariable expenses, applicable to the operation of different departments.

**SECONDARY EXPENSE DISTRIBUTION**—Secondary expense distributions consist of a redistribution of the total expenses of each service department to producing departments and other service departments. Such a distribution constitutes an indirect or redistributed charge to the departments receiving it. There are two basically different procedures followed in making service expense distributions. In some cost accounting systems service department expenses are distributed directly and entirely to producing departments only. In other cost accounting systems, service department expenses are distributed, in certain instances, to other service departments before final redistributions of total expenses of service departments are made to the producing departments.

**BASIC INFORMATION FOR PRIMARY EXPENSE DISTRIBUTION**—Procedures must be developed to ascertain certain plant expense data applicable to the different producing and service departments as follows:

- 1 Statistical information pertaining to plant layout
  - a Ground dimensions and acreage
  - b Roadways, walks and railroad sidings
  - c Buildings and dimensions
  - d Departmental occupancy of buildings
  - e Floor area of buildings
  - f Cubic content of buildings
- 2 Statistical information relating to machinery and equipment
  - a Location of equipment in departments



- 3 Accounting information relating to property
  - a Plant equipment ledger
  - b Property insurance register
  - c Patents register

The plant layout is a blueprint or drawing of entire ground area occupied by plant. The boundary lines of the land indicate measurements and acreage owned. Driveways, railroad sidings, walks, storage piles, building foundation lines, and all other pertinent data are shown and drawn to scale (see Fig 1). The plant layout also discloses departmental occupancy of each building. Names and code numbers of all departments are indicated together with the dimensions of each department, these must be known because area is used as a basis for making many expense distributions. Departmental figures of cubic content are also sometimes required, in order to make primary distribution of such items as heating expense.

A plant and equipment ledger must be maintained to give the location and other pertinent data on machinery and equipment. The record classifies by departments the location of each unit of machinery and equipment by its code number and name. The purpose of this classification is to enable the cost department to allocate depreciation and property insurance to the proper departments when the monthly primary expense distribution is made.

The property insurance register contains a record of policy premiums paid to cover all buildings, machinery, and equipment. From this register the monthly insurance expense can be identified with the property to which it applies. Accurate monthly expense charges are thereby obtained for monthly distribution of property insurance.

A patents register records the cost of each patent purchased or developed by a company. This record also discloses the department wherein the patent is applicable to manufacturing operations. From this record proper monthly patents amortization charges are obtained.

**ALLOCATION AND PRORATION OF MANUFACTURING EXPENSES**—The distribution of departmental expenses falls into two groups:

- 1 Those expense items which can be identified directly with specific departments. Such identification is known as expense allocation.
- 2 Certain joint expense items which must be distributed among two or more departments. This process is known as proration.

In practice the terms allocation, proration, and distribution are used more or less synonymously. Thus the Uniform Accounting Manual of the Rubber Manufacturing Industry uses the terms distribution and proration. This manual provides for the accumulation of overhead expenses under the following primary expense groupings:

- 1 Expense materials, supplies and miscellaneous
- 2 Indirect labor
- 3 Repairs and maintenance
- 4 Depreciation
- 5 Insurance
- 6 Taxes

These expenses through various bases of proration, find their way into productive departmental overheads, and from there to the cost of the



product passing through these productive departments. The manual states

In accomplishing the distribution of overhead the various cost elements must be considered as direct departmental overhead or as prorateable or general overhead. All expenses possible should be applied specifically as direct departmental overhead to nonproductive and productive departments. This specific application will include a large portion of the indirect labor, indirect materials and supplies, general factory expense, repairs and maintenance and fixed charges. Under the fixed charges the depreciation on the machinery and equipment in each department should be applied directly while the depreciation on land improvements, buildings and general factory buildings should be classified as prorateable overhead.

**Direct Allocation of Manufacturing Expenses**—Expenses allocated directly to specific departments are

- 1 Expenses recorded on original records
- 2 Expenses accumulated on summary records

In either case it is possible to measure exactly the benefit derived or penalty incurred by each department. In the first case the original records must indicate the specific department to which the expense is to be charged. The following illustrations are typical.

Original Records	Examples of Expenses Allocated to Specific Department
1 Purchase voucher	Coal purchased for powerhouse
2 Petty cash voucher	Street car fare for clerk in work manager's office
3 Stores requisition	Small tools, factory supplies and repair materials for use in specific producing or service departments
4 Time ticket	Indirect labor employed in specific producing or service departments
5 Defective work ticket	Spoilage identified with specific producing departments where it occurred
6 Maintenance and repair order	Maintenance and repairs made in specific producing and service departments

Where expense allocations are made from summary records they are computed and charged to specific departments by the cost department. Some examples of plant charges that indicate direct allocation to specific departments, and the summary records on which these charges are accumulated are as follows:

Summary Records	Examples of Expense Allocation
1 Departmental classification of machinery and equipment	Depreciation on machinery and equipment allocated to specific departments where units are located
2 Departmental identification of patents utilization	Patents amortization allocated to specific departments
3 Indirect labor distribution	Indirect labor classifications by the nature of their occupations allocated to specific departments

Summary Records ( <i>Cont d</i> )	Examples of Expense Allocation ( <i>Cont d</i> )
4 Workmen's compensation insurance expense analysis	Workmen's compensation insurance expense allocated to departments on basis of indirect labor expense allocation
5 Social security tax analysis	Federal and state old age benefit and unemployment compensation insurance expenses allocated to departments on basis of indirect labor expense allocation
6 Water meter reading	Water for use in specific department

**Proration of Joint Manufacturing Expenses**—Some plant expenses are shared jointly by a number of departments. The distribution of such joint expenses to the departments affected is known as proration. All expenses which cannot be directly allocated to specific departments must be prorated among the producing and service departments. Data for proration of plant expenses are prepared from summary work sheets. Some examples of expenses to be prorated are as follows:

Summary Records	Examples of Expense Proration
1 Building depreciation expense analysis	Depreciation on buildings
2 Building insurance expense analysis	Insurance on buildings
3 Building tax expense analysis	Taxes on buildings
4 Building heat expense analysis	Heat purchased for buildings
5 Building lighting expense analysis	Light purchased for buildings
6 Building maintenance and repairs expense analysis	Maintenance and repairs on buildings
7 Machine kilowatt power consumption summary	Power purchased for machine operation

The bases most commonly used in prorating expense items among producing and service departments are:

- 1 Floor area
- 2 Cubic content
- 3 Square feet of radiation
- 4 Kilowatt hours, direct labor hours, machine hours, etc.

Thus such items as building depreciation, building insurance, building maintenance, and even building taxes are quite commonly prorated on a floor area basis. Heat, if it is not meter-measured, may be distributed on the basis of the cubic content of the various departments or the floor area, or the square feet of radiation. Similarly, lighting expense may be prorated on the basis of floor area, cubic content, number of outlets, kilowatt-hours, etc., power may be distributed on the basis of rated capacities of machines, machine hours, horsepower hours, or even direct labor hours.

## Procedure for Primary Expense Distribution

**NATURE AND LIMITATIONS OF EXPENSE DISTRIBUTIONS**—A primary expense distribution represents an attempt to assign manufacturing expenses to particular departments either through precise measurement or through a process of estimating. Where expense items can be directly identified with departmental operations no particular problem arises, because the expense allocation is determined on the basis of benefit derived and is capable of exact quantitative measurement. Thus where departmental meters are installed to measure the consumption of light or power the resulting cost allocation can be said to be exact. If however, a single plant meter measures the overall consumption of light and power, the proration of these expenses results in estimated departmental costs for these expense items. All prorations are therefore estimates and as such subject to the limitations of all cost estimates. Usually no one basis of proration is free from objection, and the cost accountant is bound to effect some compromise between a theoretically perfect method and one that is suited to the practical exigencies of the local conditions. A distribution of light expense on an area basis may be perfectly satisfactory in one plant where the lighting system is uniform, and the ceiling heights do not vary. But where some departments require special lighting, such as mercury arc, fluorescent induct etc., and where different light intensities are required, and ceiling heights vary, obviously an area basis is out of the question. As nearly as possible some basis of distribution must be selected that takes into account all the factors likely to exert an influence on the behavior of the standing order expense in question. To the extent that the cost accountant must depart from such theoretical perfection he lays himself open to the objection that all such prorations are mere guesswork. The answer is that these "guesses" represent the most careful estimates possible under the given conditions and are not to be dismissed merely because they do not represent actually measured data.

**BUILDING REPAIRS AND MAINTENANCE**—Building repairs and maintenance are accounted for in one of two ways

- 1 Actual expenses incurred for repairs and maintenance each month are charged to a Building Repairs and Maintenance Expense account which is prorated at end of each month
- 2 Use of a maintenance reserve

Building repairs, particularly major repairs occurring irregularly, cause violent fluctuations in annual maintenance charges. It is often desirable to stabilize these charges by anticipating repairs for a fairly long term, and prorating such estimates to each cost period. This in effect converts maintenance into a fixed charge, since a maintenance account is debited whether repairs were made or omitted. The offsetting credit is to a reserve called variously Reserve for Repairs, Reserve for Nonrecurring Building Expense, etc., actual repairs are debited to this reserve. The above practice is quite common, steel mills, foundries, etc. often show an account "Reserve for Relining of Furnaces" which falls into this group.

Under both plans, the departmental distribution of repairs and maintenance expense is often based upon the area occupied by each depart

ment in the building expressed as a percentage of total area. A work sheet analysis of building repairs and maintenance is prepared, and the departmental totals posted to the expense distribution sheet. The departmental charges for repairs and maintenance are made from a summary of repair and maintenance charges on jobs completed or in process during the period. These charges occur in two ways:

- 1 From a distribution of repair and maintenance order costs
- 2 From a distribution of the cost of repairs and maintenance where work orders have not been issued

In this connection the Uniform Manual of the Rubber Manufacturing Industry states:

The use of work orders permits the collection of total cost viz labor material and overhead in connection with each job performed. All work orders whether or not completed during the period should be costed and charged to the proper repair and maintenance classification under the department receiving the benefit of the work. Overhead of the shop division departments should be applied as a percentage of labor performed on repair and maintenance work during the period regardless of whether a work order is used.

Where a work order has not been issued to cover a small repair or maintenance item the labor and material should be charged under the proper repair classification of the department receiving the benefit of the work.

Repair and maintenance work performed by an outside concern will be billed as a total cost. The invoice when received should be charged to the proper repair and maintenance expense classification under the department receiving the benefit of the work.

Repair and maintenance costs should be analyzed sufficiently to ascertain the cost in as many divisions as possible. The main analysis should follow the main classification of plant investment viz:

- |                                     |                          |
|-------------------------------------|--------------------------|
| 1 Land                              | 6 Molds, cores and poles |
| 2 Land improvements                 | 7 Lamps and wires        |
| 3 Buildings                         | 8 Small tools            |
| 4 Machinery and equipment           | 9 Furniture and fixtures |
| 5 Automobiles and automobile trucks |                          |

Repairs and maintenance on lands and buildings other than those assigned to the power division should be prorated to all departments as a general factory expense.

**DEPRECIATION, INSURANCE, AND TAXES**—These expenses are collected from records under the control of the following general ledger accounts:

- 1 Reserve for Depreciation
- 2 Prepaid Insurance
- 3 Prepaid or Accrued Taxes

Periodical fixed charges emanating from the above accounts are analyzed and charged departmentally under the proper expense classification. Registers of property and plant values, insurance and taxes are maintained in most factories. These records are designed to give automatically a detailed analysis of all fixed charges at the end of each month.

**Building Depreciation Expense**—A property ledger is used to classify plant investment by type of land, buildings and equipment, location and

value with accumulated depreciation for each. The proration of depreciation on buildings to departments is based upon three factors:

1. Cost of building
2. Total area of building
3. Area occupied by each department in building. This is usually reduced to a percentage of the total area.

The cost of the building is obtained from a factory building and equipment ledger. The total area of each building, and also the area of each department within a given building are obtained from a record showing departmental occupancy of buildings. From these data, a work sheet analysis of building depreciation is obtained. This analysis provides a total depreciation charge for each building and then prorates the totals where necessary to departments within each building. The rubber industry's Manual recommends a straight-line yearly rate of depreciation for each kind of property, which should be multiplied by the book value to compute the annual amount of depreciation. Depreciation starts with the month in which the installation of a property unit is completed. The analysis of depreciation expenses gives the total depreciation to be charged to each department during the period.

Depreciation on land improvements and buildings, applicable to power plant, is segregated from depreciation applicable to all other land improvements and buildings. The former is charged specifically to the power department while depreciation applicable to other land improvements and buildings is included with other expenses to be prorated departmentally on a floor area basis.

**Depreciation on Factory Machinery and Equipment**—Distribution of depreciation on machinery and equipment is made to the different departments based upon the following three factors:

1. Cost of each unit of factory equipment
2. Rate of depreciation applicable to each unit of equipment
3. Departmental location of each unit

All this information is obtained from the factory equipment ledger. A work sheet analysis of Machinery and Equipment Depreciation is prepared and this in turn provides the information for the departmental expense distribution sheet.

**Insurance**—Insurance expense consists of several types of coverages against losses from differing causes. The accounts differentiate as to fire insurance on buildings, machinery and equipment stores, goods in process, and finished goods. With the exception of fire insurance on buildings, this expense is charged departmentally on the basis of the insurable value in each department.

Fire insurance on land improvements and buildings applicable to the power plant is segregated from fire insurance applicable to all other land improvements and buildings. The former is charged specifically to the power department, while fire insurance applicable to other land improvements and buildings is included with other expenses to be prorated departmentally on a floor area basis, or some other equitable basis. In this connection, the Manual of the Rubber Manufacturing Industry states

CODE	INDIRECT LABOR ACCOUNT NAME	GRAND TOTAL	DEPARTMENTS									
			90	91	92	93	01	02	03	04	05	06
508	Repair Labor	\$ 500 00	\$ 2 425 00	\$ 125 00	\$ 125 00	\$ 250 00		\$ 1 025 00				\$ 550 00
512	Material Handlers											
513	Helpers											
514	Service Attendants											
530	Foremen											
531	Department Heads											
532	Shop Office Clerks											
	Total Indirect Labor	\$ 26 990 00	\$ 6 375 00	\$ 2 245 00	\$ 1 685 00	\$ 2 270 00	\$ 2 550 00	\$ 2 285 00	\$ 2 900 00	\$ 1 700 00	\$ 1 400 00	\$ 3 400 00
	Total Direct Labor	78 900 00	20 050 00	37 500 00	5 420 00	12 000 00						
	Total Labor	\$101 890 00	\$26 425 00	\$39 745 00	\$ 7 085 00	\$14 270 00	\$ 2 550 00	\$ 2 245 00	\$ 2 900 00	\$ 1 700 00	\$ 1 400 00	\$ 3 400 00
	Workmen's Compensation Insurance Rates		5%	4%	4%	3%	3%	4%	3%	1%	1%	5%
	Estimated Workmen's Compensation Insurance Expense	\$ 146 05	\$ 1 308 75	\$ 1 560 00	\$ 275 20	\$ 428 10	\$ 76 50	\$ 90 40	\$ 87 00	\$ 17 00	\$ 14 00	\$ 168 00

(Detailed figures purposely omitted)

Fig 2 Work Sheet Analysis of Workmen's Compensation Insurance



Poiler explosion insurance should be applied specifically to all production departments utilizing pressure vessels as well as to power departments.

Fidelity insurance will be charged to those departments whose employees are bonded under the schedule at specific cost.

Payroll robbery insurance should be charged to the payroll department.

Automobile insurance should be charged according to specific coverage provided use and occupancy, plant explosion, riot and civil commotion and elevator insurance cost should be collected with all other expenses to be prorated on a floor space basis and spread to all departments excepting those in the power division which should be charged with their pro rata share before the floor space overhead distribution is made.

**Workmen's Compensation Insurance**—Workmen's compensation and liability insurance should be accrued periodically on the books. Distribution of these items is based upon total factory labor which includes both direct and indirect labor. Compensation insurance is computed usually by applying the policy rates for the different labor operations and occupations to the current month's payroll analysis. The occupational labor hazard and casualty record for each labor operation or occupation determines the rates established by the insurance company. Each month a work sheet analysis of labor by departments similar to Fig. 2 is prepared in order to provide a basis for the computation of workmen's compensation insurance.

**Insurance on Machinery and Equipment**—Distribution of insurance on machinery and equipment is made to different departments based upon the following factors:

1. Premium expense
2. Valuation by departments
3. Analysis of equipment valuation according to different insurance premium rates

The monthly insurance premium expense on machinery is obtained from a work sheet analysis prepared from the insurance register. The

FOR THE YEAR 19\_\_

Department	Original Cost Value	Percentage	Property Insurance Rate per Annum		Monthly Charge
			\$5.00 per Thousand	\$5.00 per Thousand	
90	\$1,800,000	60%	\$ 0.00		\$ 1.00
91					
92					
93					
94					
03	\$3,000,000	100%	\$15.00		\$1,250.00
04					
05					
06					
07					
01	\$ 24,000	50%		\$ 75.00	\$ 6.00
02					
03					
04					
05					
	\$ 48,000	100%		\$114.00	\$ 12.00
Total Machinery and Equipment Insurance Expense					\$1,262.00

FIG. 3 Departmental Analysis of Insurance on Machinery and Equipment

original cost value of different units of machinery and equipment is obtained from the factory equipment ledger sheets. From these ledger sheets a departmental analysis is made of the premium rates. Fig 3 shows a portion of the departmental proration of insurance on machinery and equipment.

**Building Insurance Expense**—The basis for proration of building insurance expense is obtained from the following sources:

- 1 Building insurance premium
- 2 Total area of building
- 3 Area occupied by each department in building reduced to a per cent of the total

The monthly premium expense is obtained from a work sheet analysis prepared from the insurance register. The distribution is similar to that for Depreciation on Buildings.

**Taxes, Real and Personal**—Taxes on buildings are segregated from those on personal property. Any special taxes levied by county authorities, such as automobile taxes, are charged specifically. Taxes on land improvements and buildings, applicable to the power plant, are segregated from other taxes by being charged specifically to the power department, while taxes applicable to other land improvements and buildings are included with other expenses to be prorated departmentally on a floor area or other convenient basis. Thus the rubber industry's Manual states:

Taxes on personal property should be prorated departmentally on the basis of the taxable values in each department.

The total tax on machinery and equipment at the beginning of the year should be charged to each individual department according to the percentage relationship of machinery and equipment values in each of the total value.

The total tax on stores should be charged to the stores department.

The total tax on goods in process should be charged departmentally on basis of value at the beginning of the year, of goods in process in each department.

The total tax on finished merchandise should be charged to the finished goods warehouse department.

Taxes should be accrued monthly on the general books at the same time that the charge is made to factory overhead.

**Building Taxes**—Distribution of building taxes depends on the area occupied by each department in a building, reduced to a percentage of total. This is in contrast to personal property taxes which are distributed usually on a valuation basis. Other bases are of course possible. Where real property taxes are prepaid, the amount applicable to a given year is available from a Prepaid Property Taxes account. If property taxes are due some time after the beginning of the fiscal year the amount of taxes applicable to the fiscal year must be estimated. In the latter case the annual estimate is used in computing the proration of building taxes expense. If land taxes are assessed separately from building taxes it is necessary to prorate land taxes applicable to factory buildings proportionately to area occupied by buildings. Distribution of building taxes is similar to the computations made for other expenses handled on an area basis.

**Social Security Taxes**—Distribution of this expense item is prepared from same labor work sheet analysis used to compute workmen's compensation insurance (Fig 2)

The payroll tax rates applicable for a given year are multiplied by the departmental labor distribution totals in order to arrive at the allocation of departmental expense for social security taxes. Assuming a rate of 3% for unemployment insurance, and 1% for old age benefits, the allocation appears as follows:

Department	Payroll (Fig 2)	Social Security Tax at 4%
90	\$ 26 175 00	\$1 047 00
91	39 745 00	1,589 80
92	7 085 00	283 40
93	14 270 00	570 80
01	2 550 00	102 00
02	2 265 00	90 60
03	2 900 00	116 00
04	1 700 00	68 00
05	1 000 00	64 00
06	3 000 00	144 00
	<u>\$101 890 00</u>	<u>\$4 075 00</u>

**FACTORY SUPPLIES**—These include the cost of all materials and supplies that do not form part of, or cannot be applied directly to any article produced. The primary expense distribution of factory supplies is made by two sortings of stores requisitions:

- 1 Segregating all requisitions that indicate a charge to the account **Factory Supplies**
- 2 Arranging these requisitions by departmental numbers

After this sorting is made, an adding machine tape is run off which shows the allocation of expense to departments.

**FACTORY OFFICE SUPPLIES**—There are two ways to account for this item of expense:

- 1 All purchases of factory office supplies are capitalized and charged to an inventory account. When supplies are needed they are requisitioned and charged to the departments requisitioning them using the requisition as a basic voucher.
- 2 All purchases of factory office supplies are charged directly to expense from the purchase vouchers. From these the primary expense allocation is obtained either by a daily pick up analysis or by a summary analysis at the end of the month.

**FUEL EXPENSE**—Purchase of fuel may be accounted for either by charging the purchase cost to an inventory account or directly to an expense account. Under the former plan, allocation of fuel expense to departments is based upon the quantities consumed by each department using fuel. Quantities used are measured by actually weighing the issues (coal and coke), or by meter measurement of the consumption (fuel oil, gasoline, kerosene, and gas), or by merely estimating the issues. Where fuel is charged to expense at time of purchase the departmental allocation is made on the **purchase voucher**.

**GENERAL FACTORY EXPENSE**—Most expenses can be identified with a functional division or department. However, regardless of how finely a plant is departmentalized, expenses arise which are general to all departments of a plant. In order to collect these expenses a departmental account is set up termed General Factory Expense, to which such expenses should be charged.

**INDIRECT LABOR**—The expense distribution of indirect labor is obtained from an indirect labor or payroll distribution sheet. The latter provides departmental totals of various kinds of indirect labor which are transferred from the labor distribution sheet to the manufacturing expense distribution sheet. In this way, the cost of indirect labor is analyzed first by departments and then by classification under each department.

**MEDICAL SERVICE EXPENSE**—Where services of a physician and surgeon are paid for on a monthly retainer fee basis the primary expense distribution is usually charged directly to a general service department account. Through a secondary distribution the latter is prorated to other departments on one of the following bases:

- 1 Departmental casualty record
- 2 Number of workmen employed in each department
- 3 Departmental labor cost analysis

The department casualty record is probably the best of the three bases to use, because it provides medical service expense in proportion to the number of casualties in each department. The number of workmen employed in each department, when used as a basis for prorating medical services expense, is not as equitable as the first. The expense in this case is prorated on a standing or ready-to-serve basis rather than upon an actual experience basis. The departmental labor cost analysis has little merit as a basis for prorating medical expense. The usual explanation is that the departmental labor cost analysis must be obtained for other purposes and therefore it is available as a basis for prorating medical expense. There is usually no definite relationship between labor cost of each department and departmental casualties.

**PATENT AMORTIZATION EXPENSE**—Allocation of patent amortization expense depends upon the location of patent utilization. As patent costs are capitalized, a record is made of the department in which the patent is to be used. From this record, a monthly work sheet analysis is obtained for distribution.

**RELINING EXPENSE**—This expense item is allocated to the department where the furnaces are located. The estimated relining expense is based upon past experience. The life of the lining after installation and the past average actual cost are the two factors considered in estimating the monthly expense total. Where possible, the life of the lining is estimated in terms of units of product, and a monthly journal voucher is prepared on the basis of the month's production.

1 Total estimated relining cost	\$ 5 000
2 Number of tons processed before new lining is necessary	50 000
3 Cost per processed ton (Line 1 — line 2)	\$ 10
4 Production for January	500 tons
5 Charge to January operations (Line 3 × line 4)	\$50

**ROYALTIES**—Royalties paid for use of a machine or process, whether based upon units produced or a fixed monthly or annual rental, are a factory cost but where royalty payments are based upon units sold or upon a percentage of the sales values, they are often treated as deductions from sales under commercial expense. In the interests of standardization the manual of the rubber manufacturing industry suggests handling details in the following manner:

- 1 Specifically apply the unit royalty cost as a separate item of factory cost (in addition to labor material overhead) to each product manufactured by size and kind during the period when paid on a production basis
- 2 Specifically apply the royalty cost as a separate deduction from sales under commercial expense to each product sold by size and kind during the period when paid on the basis of units sold or as a percentage of sales value
- 3 The method outlined above will consist of debiting Goods in Process and/or Deductions from Sales and crediting the General ledger Royalty Accrued account

**SMALL TOOLS EXPENSE**—Three basically different methods are used to allocate the expense of small tools. At the time of purchase, such tools may be:

- 1 Capitalized in a Small Tools account
- 2 Charged to Stores
- 3 Charged to Expense

**Capitalization Method**—All purchases of small tools are capitalized in a Small Tools account which is considered a fixed asset. Depreciation is applied in order to establish annual and monthly amounts to charge off as expense. This is a difficult method to administer properly because of the variation in, and the uncertainty of, the length of life of many different small tools. Under this method, the monthly allocation of small tools expense is similar to that used for depreciation of machinery and equipment.

A variation of this method is to capitalize tool purchases, but in lieu of measuring depreciation to revalue them at the beginning and end of each period. The balance of the account after inventory appraisal as recorded represents tool expense.

**Charging Stores**—All small tool purchases are charged to stores in inventory. As tools are needed, they are requisitioned and charged to the proper department at the end of each month by being sorted departmentally. This is apparently the method advocated by the rubber industry's manual which states:

Small tools and other miscellaneous plant equipment may be charged to overhead as issued from stores, in lieu of depreciation, leaving the original equipment value on the books as an asset. When this plan is followed care should be taken that the asset does not become over- or undervalued.

**Charging Expense**—Small tool purchases are charged to expense at the time of purchase. This method is common because of its simplicity. Analysis is made of all purchase vouchers which indicate a charge to the account for Small Tools in order to allocate charges to the several departments. Analysis may be made from day to day on pick up analysis

sheets if purchases made during month are numerous. If purchases are comparatively few, analysis is made at end of month.

**Charges for Patterns, Tools, Dies, Etc.**—Where patterns, special tools or dies are made for a special job, the entire cost is chargeable to the job. Where patterns, tools and dies are made for changes in a model to extend over a period of a year the charges are amortized on different basis. One large automobile company has adopted the following method of charging these items to production:

**COST OF PATTERNS, TOOLS, DIES—Model 193 \$600 000**

	Amount to be Absorbed	Estimated Production Units
January	\$ 50 000	10 000
February	35 000	7 000
March	60 000	12 000
April	85 000	17 000
May	85 000	17 000
June	05 000	13 000
July	55 000	11 000
August	50 000	10 000
September	45 000	9 000
October	30 000	6 000
November	25 000	5 000
December	15 000	3 000
<b>Totals</b>	<u>\$600 000</u>	<u>120 000</u>

Under this plan 10,000/120,000 or 1/12 of the cost is allocated to January production. If actual production for January were only 8,000 units, these units would stand only then estimated share of the January charges for patterns, tools and dies. The excess charges for the 2,000 units not produced become a charge to unabsorbed items. If in February the production totaled 10,000 units, the correct charge for patterns, tools, and dies is made, and the excess credited to unabsorbed items. As production is equalized over a period of months the cumulative charge or credit for unabsorbed items is properly adjusted. In production of products where changes in model or design require charging off of patterns, tools, and dies, the method outlined has the advantage of making each unit produced stand its correct share of pattern, tool, and die expense. These charges therefore become a direct charge of production.

In plants where model changes are not important and standard production is involved, patterns, tools and dies are depreciated over their life and charged to production as burden, in common with depreciation on other machinery and equipment.

**WATER EXPENSE**—Where water is purchased from a public utility company, a bill is rendered based on meter readings. However where bills are rendered quarterly, the expense must be estimated. The schedule of rates provided by the utility company is then used to ascertain the estimated water expense. This computation provides the basis for the allocation of water expense. The computation of water expense and its allocation to departments may be illustrated as follows:

Department Number	Name	Meter Readings		Gallons Consumed	Estimated Expense
		Beginning of Month	End of Month		
02	Heat treating	867 000	899 260	32 260	\$ 36 00
03	General plant	1 916 000	1 960 310	44 310	50 00
06	Powerhouse	27 100 000	27 308 91	208 912	360 00
Total gallons consumed				<u>245 482</u>	<u>\$346 00</u>
Public Utility Company Rate Schedule					
First	10 000 gallons @ \$3 00 per thousand				\$ 30 00
Next	20 000 gallons @ 2 00 per thousand				40 00
Next	316 000 gallons @ 1 00 per thousand				316 00
Total Estimated Water Expense					<u>\$386 00</u>

Cost per 1 000 gals =  $\frac{\$386}{316} = \$1 15607$

The unit cost of \$1 15607 forms the basis for departmental charges by multiplying the gallons consumed in each department by the unit cost. The results are shown in the last column of the above table under the heading Estimated Expense.

## Expense Distribution Sheet

### OPERATION OF EXPENSE DISTRIBUTION SHEET—

There are four steps in the preparation of an expense distribution sheet for primary distribution:

- 1 Designing expense distribution sheet
- 2 Transferring manufacturing expense account balances from their subsidiary expense ledger
- 3 Distribution of expenses to departments
- 4 Proving departmental column totals with subtotal and grand total columns

The design of the expense distribution sheet is illustrated in Fig 4, it is used in conjunction with a single Manufacturing Expense control account, and is usually prepared on columnar analysis paper. Specific expense accounts should be arranged in the left-hand margin in exactly

(31)

CODE	NAME	PRODUCING DEPARTMENT				SERVICE DEPARTMENTS							SUB-TOTAL
		EXPENSE TOTAL	50 MACHINE SHOP	91 FINISHING	92 HEATING	93 ASSEMBLY	94 FLOORING	95 ENGINEERING	96 STORAGE	97 FACTORY ACCOUNTING	98 GENERAL PLANT	99 NON-EXPENSE	
501	Fact ry 5 poling	5 2 946 65	1 821 12 5	745 38 2	62 2	246 45	618 15						
502	Shed 7 Tools												
503	Factory office 5 april 5												
504	Fuel	1 519 2	559 27	642 80	61 60	91 60	1 094 00						
505	Water												
506	Defect work loose												
507	Equip r Helo lists												
508	Equip r Helo lists												
509	Repair Labor Eq pms												
510	Repair Labor Eq pms												
511	Repair Labor Eq pms												
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DIVISION 70 - GENERAL PRODUCTIVE									
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expenses constituting direct charges to departments appear under their proper headings

Proof of the accuracy of the expense distribution sheet is obtained after all allocations and provisions have been entered in the proper columns. First, the producing and service department horizontal subtotals of each item are obtained, the sum of the two subtotals for each expense item should equal the grand total for that item. Next the vertical column totals are obtained for each producing and service department. The column totals for each group of departments are then crossfooted and checked against the subtotal columns. This procedure insures the accuracy of all department totals before secondary expense distributions are made.

Figs 5 and 6 show portions of distribution sheets used in a large steel foundry. Fig 5 is for producing departments. Fig 6 for service departments. The complete columnar headings for Fig 5 are as follows:

70-1 Melted Metals  
70-5 Cleaning and Finishing  
70-7 Second Cleaning and Finishing  
70-9 Routine Heat Treatment  
70-11 Special Heat Treatment  
70-13 Pattern Shop  
70-17 Machine Shop Rolls  
Current Month Total  
Total to Date

Each column is subdivided into

1 Quantity and Hours  
2 Amount  
3 Cost per Net Ton

For Fig 6, the service department group, the complete column headings are

80-1 Building Rent  
80-3 Power and Light  
80-5 Heating  
80-7 Cost  
80-9 Purchasing  
80-11 Waste Management  
80-13 General Superintendent  
80-15 Drainage  
80-17 Receiving  
Current Month Total  
Total to Date

Each column is subdivided into

1 Quantity and Hours  
2 Amount

After the service department expenses have been accumulated on Fig 6 they are transferred to another form from which secondary expense distributions are made. It is called in the Steel Founders' Manual an apportionment distribution sheet (see Fig 9, discussed later in this section). The complete list of accounts on the expense distribution sheets (Figs 5 and 6) is as follows:

Code	Producing Departments	Service Departments
	<b>INDIRECT LABOR</b>	<b>INDIRECT LABOR</b>
150	Foremen and Assistants	Foremen and Assistants
152	Clerks	Clerks
153	Helpers	
154	Chargers	
155	Crane men	Crane men
156	Crane men and Shakedown	Crane men and Shakedown
157	Weldmen	
159	Tool Tenders	
160	Dry Core Finders	
162	Pattern Carriers	
163	Pattern Estimators	
164	Pattern Cup Makers	
165	Patternmen and Helpers	
166		Skinner
167		Watchmen
168		Special Apprentices
169		Vacations and Sickness
170		Miscellaneous and General Repairsmen
171	Firemen	Firemen
172		Engineers
173		Locomotive Crane Operators
174		Locomotive Crane Fireman
175		Hostlers
176		Gangway and Templars
177	Allowances Vacation	
178	Allowances Overtime	
179	General Labor	General Labor
180	Idle Time	Idle Time
181	Other Allowances	Allowance and Overtime
182		Janitors
183	Total Indirect Labor	Total Indirect Labor
	<b>MANUFACTURING SUPPLIES</b>	<b>MANUFACTURING SUPPLIES</b>
200	Molding Sand	
201	Lime	
202	Lime Clay	
203	Silica Sand Ground	
204	Coke Briquets	
205	Roll Blacking	
206	Flour	
207	Bentonite and Dextrine	
208	Sawdust	
209	Molasses	
210	Core Oil	
211	Foundry Nails	
212	Charcoal	
213	Castor Rods Bar Iron and Steel	
214	Miscellaneous Manufacturing Supplies	Miscellaneous Manufacturing Supplies
	Total Manufacturing Supplies	Total Manufacturing Supplies
	<b>GENERAL STORES</b>	<b>GENERAL STORES</b>
250	Small Tools	Small Tools
251	Shop Castings Wedges and Chills	
252	Bolts, Nuts Washers Screws and Nails	Bolts Nuts Washers Screws and Nails
253	Hose and Hose Connections	
254	Lathe Centers	
255	Tool Steel	
256	Steel and Iron Stock	Steel and Iron Stock
257	Oils Greases and Gasoline	Oils Greases and Gasoline
258	Waste and Rags	Waste and Rags
259	Open Hearth Sand	

(Continued on page 976)

MANUFACTURING BURDEN				MONTH ENDED Jan 31, 19--			
DIVISION NO. SERVICE DEPARTMENTS							
DEPT. NO.	NAME OF ACCOUNT	NO. 1. LOC. REPT.		NO. 17. CREDIT Q.		CURRENT AND TH. Q.	
		QUAN. & PER. S.	AMOUNT	QUAN. & PER. S.	AMOUNT	QUAN. & PER. S.	AMOUNT
	<b>Indirect Labor</b>						
150	Foremen and Assistants						
152	Clerks						
153	Craftsmen						
156	Chambers and Shilover						
166	Salaries						
176	W. S. S. S.						
177	Special Approaches						
178	Vacations and Sickness						
179	Maintenance and Gen. Expenses						
180	Furnish						
181	Engineers						
182	Locomotive L. and Operators						
183	Locomotive L. and Drivers						
184	Hand in						
185	Gas and Trolleys						
191	General Labor						
196	Life Time						
197	Allowance and Overhead						
198	Junior						
	T. of Indirect Labor						
	Manufacturing Supplies						
49	Miscellaneous Mfg. Supplies						
	Total Manufacturing Supplies						
	General Stores						
-30	Small Tools						
212	Steel, Nuts, Washers, Screws and Nails						
36	Steel and Iron Stock						
257	Oils, Greases and Lubricants						
258	Wear and Tear						
45	Working Tools						
70	Lumber						
72	Compound						
74	Tin						
79	Miscellaneous General Stores						
	Total						

280	Fuel Oil						
285	Lard Oil						
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Code	Producing Departments	Service Departments
	GENERAL STORES (Cont d)	GENERAL STORES (Cont d)
262	Grinding Wheels	
263	Welding Carbon	
264	Welding Wire	
265	Welding Gases	Welding, Gases
266	Pilot and Dowel Stock	
267	Paint	
269	Shellac Glue and Putty	
270	Sand Blast Shot	Lumber
271	Lumber	
272	Heat Treating Oil	Compound
273	Compound	Ties
274		Miscellaneous General Stores
289	Miscellaneous General Stores Total	Miscellaneous General Stores Total
290	Fuel Oil	Fuel Oil
295	Coal Coke and Charcoal	Coal Coke and Charcoal
	Total General Stores	Total General Stores
	MISCELLANEOUS EXPENSE	MISCELLANEOUS EXPENSE
300	Refuse Expense	
301	Small Tools Purchased	Small Tools Purchased
302	Machine Shop Work—Tools Roll Cutters etc	
303		Traveling and Entertainment
304		Privat Club Expense
305		Outside Physician Expense
306		Outside Hospital Expense
307		Ambulance Expense
308		X Ray Expense
309		Compensation Expense
310		Legal Expense
311		Goggles
312		Safety Signs
313		Printing Safety Forms
314		Hospital Supplies
315		Drinking Water and Ice
316	Shop Castings	
317		Undistributed Freight
318		Chemicals
319		Crucibles
320		Outside Trucking Expense
321		Tire Expense
322		License Fees
323		Photostat and Blueprinting Paper
324		Salvaged Materials
325		Demurrage and Car Rental
326		Outside Inspection
327		Test Bars
328		Weighing
329		Fire Department Expense
330		Welfare
340	Old Age Pension Expense	
341	Water	Water
342	Experimental and Development Expense	
349	Miscellaneous Expense	Miscellaneous Expense
358	Insurance Compensation and Pub lic Liability	Insurance Compensation and Public Liability
369	Insurance Group Total	Insurance Group Total
380	Refrining Furnace Expense	
391	Defective Work Before Shipment	
392	Defective Work After Shipment	

Code	Producing Departments	Service Departments
	MISCELLANEOUS EXPENSE (Cont'd)	MISCELLANEOUS EXPENSE (Cont'd)
395	Purchased Power	Purchased Power
397	Gas	Gas
	Total Miscellaneous Expense	Total Miscellaneous Expense
	REPAIRS	REPAIRS
400	Repairs Labor	Repairs Labor
401	Repairs Manufacturing Supplies	Repairs Manufacturing Supplies
402	Repairs General Stores	Repairs General Stores
403	Repairs Miscellaneous Expense	Repairs Miscellaneous Expense
	Total Repairs	Total Repairs
	AUXILIARY DEPARTMENTS COST	Total Controllable Burden
430	Steam Mill Cost	
431	Dry Oven Cost	
433	Cutting Gas Manufacturing Cost	
	Total Auxiliary Departments Cost	
	Total Controllable Burden	
	FIXED AND SERVICE DEPARTMENTS COST	FIXED AND SERVICE DEPARTMENTS COST
460	Taxes	Taxes
461	Depreciation	Depreciation
462	Insurance General	Insurance General
	Total	Total
470	Service Department Charges	Service Department Charges
	Total Fixed and Service Departments Cost	Total Fixed and Service Departments Cost
	Total Actual Burden	Total Departmental Cost

**SECONDARY EXPENSE DISTRIBUTION**—The final stage in the completion of the expense distribution sheet consists of making the secondary expense distributions. This involves a redistribution of service department expenses in such a way that ultimately all expenses are lodged in producing department accounts. This is because the product travels through the producing departments only and must therefore absorb the entire plant overhead in those departments.

**BASES FOR DISTRIBUTING SERVICE DEPARTMENT EXPENSES**—The distribution of service department expenses is made on one of two plans as follows:

1. Service department expenses may be distributed in their entirety only to producing departments.
2. A proportion of service department expense totals may be distributed to other service departments before final expense distributions are made to producing departments.

Irrespective of the plan utilized the fundamental factor of importance is to use a proper basis for distribution of specific service department expense. In selecting such a basis two factors are involved:

1. Nature of the service rendered by the specific service department.
2. Number of specific departments which utilize such service.

The Rubber Manufacturers' Association, in its Uniform Accounting Manual classifies all service departments according to their basis of distribution. It recommends the use of seven bases:

- 1 Meter readings or engineers' estimates
- 2 Number of employees total labor hours or total labor dollars
- 3 Direct charges to productive departments
- 4 Relative floor space area (excepting power division)
- 5 Additions to cost of material or supplies
- 6 Specific application to repair or new work orders
- 7 Charges to general ledger control

In addition there may be found many other bases such as

- 1 Machine hours
- 2 Truck hours
- 3 Crane hours
- 4 Cubic content
- 5 Property valuation, etc

There is no uniform application of a particular basis in the distribution of a given service department. The choice of a basis is either a matter of individual bias or depends on the existence of some specific condition. The application of the seven bases mentioned in the Rubber Manual is discussed below. Reference is also made to service distributions recommended by the Steel Founders' Society of America Inc in its Uniform Accounting and Cost Plan for Steel and Alloy Foundries.

**Meter Readings or Engineers' Estimates**—Meter readings apply to power costs which should be departmentalized according to the needs of each company as follows

- |                                      |  |
|--------------------------------------|--|
| 1 Steam Generation Department        | 6 High Pressure Service Water Department |
| 2 Electrical Generation Department   | 7 Low Pressure Service Water Department  |
| 3 Electrical Transmission Department | 8 Gas Department                         |
| 4 Compressed Air Department          | 9 Drinking Water System Department       |
| 5 Hydraulic Power Department         |  |

The engineering division furnishes separate meter readings of these factors for their proportion to the departments consuming the power.

**Number of Employees, Total Labor Hours, or Total Labor Dollars in All Departments**—All departmental expenses which bear a direct relation to the number of employees working in the plant, and which vary more or less in direct proportion as the number of employees are prorated on the above basis. According to the Rubber Manual this classification contains the following expenses

- |  |   |
|--|---|
| Factory Managers Department  | Cafeteria Department (proportion of loss or gain applying to factory in relationship of factory employees to total employees) |
| Employment Department  | Timekeeping Department  |
| Medical Department   | Payroll Department  |
| Welfare Department (including employees' life insurance)               | General Factory Expenses  |
| Police Department (other than watchmen)                                | Donations and Subscriptions   |
| Safety and Sanitation Department (proportion applying to factory only) | Books and Periodicals   |
|  | Factory Council Salaries  |
|  | Cost of Drinking Water  |

Along similar lines, the Steel Founders' Manual lists the following departments



Work Management  
General Superintendence  
Production Planning Department  
(including time study)  
Payroll Department

Cost Department  
Employment and Welfare Department  
Safety and Dispensary Department

The expense of each of these departments will be accumulated in a separate account including salaries repairs to equipment general stores materials miscellaneous expense fixed charges and then share of any of the service departments listed above in which they participate for the purpose of distribution however their totals will be added together and printed in a single distribution to all productive auxiliary and remaining service departments on the basis of payroll hours.

Some industrial concerns distribute the expenses of service departments on the basis of direct labor cost. The reason for use of the direct labor cost basis is its ease and simplicity. The departmental payroll analyses are prepared as matter of routine and hence these are used, thus obviating the necessity for gathering data for other distribution bases. In fact the Steel Founders' Manual specifically authorizes the use of payroll dollars in lieu of payroll hours as a basis if payroll hours cannot be conveniently obtained. It is to be noted however, that the use of the direct labor cost basis may result in an inequitable expense distribution particularly if hourly rates paid to direct laborers vary widely.

**Direct Charges to Productive Departments**—Expenses collected under this classification of service factors are allocatable directly to productive departments by specific application of activities or estimated benefit realized. The following departments are included in this category (Rubber Manual)

General Research Laboratories  
Chemical Testing Department  
Physical Testing Department  
Experimental and Development  
Test Cell Department  
Technical Service  
Specification Department  
Garage Department  
Central Trucking Department

General Yard Department  
Drafting Department  
Taking Inventory  
Cost Department  
Factory Accounting Department  
Time Study Department  
Production Planning Department  
Scheduling Department

The examples below, taken from the Steel Founders' Manual, fall into the same group.

**Z 23 General Engineering**—The entire cost of this department including direct charges such as indirect labor (salaries) miscellaneous expense (photostat and blueprint paper, travelling) repairs and its share of the foregoing service departments will be distributed among the various productive and auxiliary departments and the selling expense account 'Sales Engineering Expense' P 10 on the basis of service rendered.

**Z 24 Repairs and Maintenance Department**—The entire expense of this department (exclusive of labor and repair materials charged direct to the repair accounts of departments served) will be distributed to these various departments on the basis of repair labor hours furnished by the repair and maintenance department.

**Z 26 Fuel Oil Storage**—The entire expense of this department including taxes, depreciation insurance, and power service will be distributed over the various productive and auxiliary departments which use this fuel on the basis of gallons consumed.

**Relative Floor Space**—All general factory expenses incurred in relation to buildings or building space, are prorated to all departments on the basis of the floor space occupied by each department. According to the Rubber Manual, unoccupied space such as aisles passageways, bridges, halls, etc. should be applied in proportion to the occupied space charged to each department. The following departments are included:

**Fire Department**

**General Factory Expense**

Watchmen  
Sweepers and Cleaners  
Elevator Operators  
Snow and Ice Removal  
Repairs and Maintenance on Land Improvements (except power plant)  
Repairs and Maintenance on Buildings and Building Equipment (except power plant)  
Depreciation Land Improvements (except power plant)  
Depreciation, Buildings and Building Equipment (except power plant)

**General Factory Expense (cont'd)**

Fire Insurance, Buildings (except power plant)  
Tornado Insurance  
Use and Occupancy Insurance  
Plant Explosion Insurance (except boiler explosion)  
Riot and Civil Commotion Insurance  
Elevator Insurance  
Taxes on Building and Building Equipment (except power plant)  
Cost of Electric Lighting (general plant only)

The Steel Founders' Manual discusses the floor area basis as follows:

**Z 4 5, 6 Floor Space Rental**—Floor space rental will be subdivided to office buildings and foundry buildings groups A and B. The entire cost of these departments including heating, electric light, indirect labor (watchmen and janitors), stores, materials, repairs, taxes, depreciation and insurance on buildings will be prorated over the various departments housed in each on the basis of areas occupied (square feet).

**Note**—A separate floor space rental account should be carried for each major building or group of buildings such as offices, foundry and machine shops.

**Z 25 Pattern Storage**—The entire expense of this department including labor, repairs, floor space rental, etc. will be distributed over the several molding and core departments on the basis of estimated use of storage space.

**Addition to Cost of Materials and Supplies**—In many plants the tendency seems to be to distribute purchasing expense and storesroom expense indirectly. In the rubber manufacturing industry, material costs are increased by the expenses connected with the following departments:

**Purchasing Department**

**Receiving Department**

**Stores Department**

**Invoice Auditing Department**

**Traffic Department (incoming materials)**

**Material Testing Department**

Expenses are collected according to these functions and are closed to an account called "Cost of Receiving and Handling Materials." The invoice cost is then increased by an estimated material burden charge to cover the cost of buying and handling the item. The rubber industry's Manual advocates the following bases:

1. Material handling costs for the major direct materials such as rubber, reclaimed rubber, other compounding materials and textiles should be recovered in cost on a tonnage basis.

- 2 The material handling expense for all other materials and supplies should be recovered in cost on a value basis

The effect is to debit Stores and to credit Absorbed Material Handling Expense. After the actual cost of Receiving and Handling is closed into Absorbed Expense and any difference disposed of in the same manner as other over- and underapplied expense

**Specific Application to Repair or New Work Orders**—The overhead of mechanical shops should be departmentalized according to the needs of each company as suggested below (Rubber Manual)

Mold and Core Department	Toolroom Department
Machine Shop and Maintenance Department	Electrical Maintenance Department

The overhead for the above departments is applied to repair and new work orders as a percentage of direct labor. Companies operating highly specialized machine shops and mold and core departments may, however, apply these overheads to work orders on a machine hour basis

**Charges to General Ledger Control**—Overheads of the shipping and finished goods warehouse departments are charged to the general ledger control and taken up on the books as a commercial expense

**SECONDARY DISTRIBUTION FOR SPECIFIC DEPARTMENTS**—Below are listed a number of the more common service departments and the procedure involved in assembling the data for making the distributions, finally suggestions are presented in each case for the distribution of the service department charge in question. The suggestions are not final and other methods may with equal appropriateness be used depending on the local conditions

- 1 Operating expenses are absorbed by being charged to repair orders on basis of labor hours
- 2 In turn repair orders are charged to departments affected on the basis of actual repairs made

A more expedient but less equitable basis for distributing this repair service is on basis of direct labor hours in the several producing departments. The argument for its use is that blacksmith repairs are usually made exclusively for producing departments and that there is a definite relationship between departmental direct labor hours and repairs required for producing departments. The same argument is also advanced

for the use of **machine hours** as a basis for distribution of service expense of this type. However, specific allocation based upon repair order records seems the most equitable basis.

**Building Occupancy**—In some cost systems, the primary expenses applicable to all departments housed within factory buildings are accumulated and charged to a Building Occupancy account. Floor area of a building is the generally accepted basis for distributing such expenses as building depreciation, insurance, taxes, maintenance, and repairs among the several departments located within a building. This is fair enough even where a certain department may be located in the center of a building, and has no exterior walls. Yet, since it is a department within the building, it is charged with its pro-rata share of depreciation, taxes, insurance, maintenance, and repairs that pertain to all of the side walls, since it could not carry on its operations unless there were side walls protecting the building.

**Cafeteria**—The secondary distribution depends upon the policy of the company with respect to prices charged employees for food. The cafeteria income is credited against cafeteria service expense. If income exceeds expense, the balance is considered "Other Income." Where cafeteria service expense exceeds the income of this department, it may be redistributed on the basis of the number of employees on the payroll of each department. But where all employees do not use cafeteria, or where they use it irregularly, the most accurate basis to employ would be a daily count and identification of employees using the cafeteria by departments in which they work. This daily statistical analysis, however, is usually too burdensome and is not commensurate with the value of the results obtained.

**Carpenter Repair Shop**—Carpenter repair service is performed for buildings and for departmental equipment such as benches, tables, cupboards, etc. Its handling is similar to blacksmith repair service. Written repair orders bear designating numbers that identify them as carpenter repair orders, they also designate either the department for which repairs are made, or Building Occupancy account, or Reserve for Building Repairs and Maintenance account, whichever the case may be. Repair materials and repair labor are charged to each specific order. At the end of the month the carpenter shop's expenses are prorated among all orders on the basis of carpenter repair labor hours. Total carpenter repair shop expense is then distributed as follows:

- 1 To specific departments for carpenter repairs made on departmental equipment
- 2 To Building Occupancy Service Department for carpenter repairs made on factory building or to a Reserve for Building Maintenance where such a method is used
- 3 To Marketing Expense or Administrative Expense general ledger accounts for carpenter repairs made to either buildings or equipment classified under these two divisions of the plant

Alternate bases, such as direct labor hours or direct labor costs of departments affected, which may be used to distribute this service expense, are apt to be arbitrary and may lead to gross inaccuracies in service expense distributions.

Exactly the same method as explained above is used in the case of the electric repair shop

**Employee Training**—Employees are usually trained to perform specific operations. A fair basis for distributing this expense is on basis of the number of employees trained each month for each department. If the length of the training period varies with different departments the number of training hours would seem to be a better basis.

**Employment Service**—The employment or personnel department renders a wide variety of services affecting all employees. The most equitable basis for distribution of employment department expense is the average number of employees on the departmental payrolls each month.

**Engineering Maintenance**—This type of engineering service deals exclusively with current productive activities. Actual repairs and maintenance service should be accounted for by the use of repair and maintenance orders. In this manner, repair materials and labor, and the department's expenses are definitely allocated to departments. If desired a portion of engineering maintenance expense pertaining to general services such as periodic inspection and lubrication may be distributed on a basis of machine hours.

**Time and Motion Study and Rate Setting**—This engineering expense relates to manufacturing activities, and it is distributed in its entirety among departments on the basis of time spent in making the studies. The engineers engaged in this work should show on their daily time tickets the department in which this class of work is performed. Thus, the basis for distribution of this expense is specific allocation to departments which is made monthly from an analysis of daily time tickets of time and motion study engineers.

**Planning and Production Control**—The amount is distributed each month among the producing departments. Specific allocation is based upon the number of items appearing on production orders and then accompanying specification schedules. Items in this instance are departmental operations, tools, and materials, which are planned and specified on each order, and which must be provided for the purpose of carrying on the production in each department.

**Factory Accounting Service**—The factory accounting department accounts for materials, men, machinery, and tools. The different activities accounted for are so valued that it is difficult to provide a common denominator that measures definitely and accurately the amount of service rendered in each department of plant. A basis that seems to distribute factory accounting service expense most fairly is the number of man hours of factory workmen. However the following bases are also advocated:

1. Number of men
2. Number of time tickets handled
3. Equal distribution

**Fire Protection Service**—This department renders service to all divisions of the plant. A portion of the total fire service expense, therefore,

may be distributed to the marketing and administrative divisions of business. There are two bases which may be used to distribute this expense:

- 1 Valuation of property protected within several departments and divisions
- 2 Valuation of property protected as weighted by fire hazard experience

Property valuation for a specific department includes the value of machinery and equipment located therein plus a proportion of the building valuation based upon floor area occupied by department. Fire hazard experience as a weighting factor may be employed where occurrence of fires is frequent and where there is a constant hazard in certain departments owing to the nature of the productive activities therein.

**Floating Labor Service**—This service is rendered to all departments as occasion requires. The foreman of the labor gang prepares a daily report which indicates the number of hours worked by each laborer for certain departments. The proper basis for distribution of this service expense is by specific allocation to departments based upon monthly analysis of time tickets of the labor gang. The total hours worked by the labor gang is divided into the total expense. The resultant cost per hour of floating labor gang service is allocated to departments which utilize this service.

**General Plant Service**—Expenses charged to this service department are those which apply to the plant in general, and which cannot expediently be allocated or prorated to specific departments. Two bases are used to distribute general plant expense:

- 1 Units of productive output
- 2 Total man hours

Unit of productive output (tonnage) is used by some steel mills to distribute general plant or general works expense. Tonnage in this type of industry is a better basis than total labor hours, because it is more uniformly representative of production in the several manufacturing divisions than total labor or man hours.

Total man hours is considered a fair basis for distributing general plant service expense where labor is a common and dominant factor of production in all departments. This is particularly true where general plant service includes general supervision, which affects indirectly all workmen.

**Hospital and Medical Service**—The service provided by this department may include employees of the marketing and administrative divisions. In such case, a portion of this service expense is distributed monthly to these other divisions. Where the department provides medical examinations to all new employees and periodical examinations to all old employees, the expense of this service should be segregated from hospital expense which provides for casualties. Two bases may be used to distribute this expense:

- 1 Number of employees
- 2 Statistical analysis of casualty experience

The first basis is simpler and is a fair basis to apply if the casualty records of each department in relation to number of employees are fairly uniform. If the casualty rate is disproportionate to the number of employees in departments, this expense should be distributed among departments based upon a monthly statistical record of use of this service by departments. Where both medical examinations and hospital care are provided, a combination basis may be used. The number of employees may be weighted by the casualty record to provide for a fair expense distribution.

**Locomotive Crane Service**—This service is provided for different producing and service departments as the services of a crane are requested. A record of the time worked for each department is shown on the daily time ticket of the crane operator. There are two bases used to distribute locomotive crane service expense:

- 1 Crane hours
- 2 Weight of materials handled

The crane hour basis is a plan generally used to distribute locomotive crane expense. Total crane operating expense is divided by the total crane hours operated in order to compute the cost per hour for crane operation. The hourly rate multiplied by the number of hours that the crane works for a given department establishes the departmental charge.

In some plants, the weight of materials which the locomotive crane handles for different departments is easily obtained. Where this information is available the weight basis furnishes a more accurate and truly representative basis for expense distribution. Concerning this point the Steel Founders' Manual states:

**Z 21 Locomotive Cranes**—The entire cost of this department, including direct charges such as indirect labor (firemen and engineers), stores, materials, fuel, repairs, fixed charges such as taxes, depreciation and insurance and its share of the foregoing service departments will be distributed between the shipping department account P 9 in the selling and general expense ledger and the service department, Receiving and Storage of Metals and Manufacturing Supplies, Z 22. The basis for distribution should be crane operating hours.

**Payroll Service**—Factory payroll service applies to all departments in the plant. Since this department accounts for the time worked by all factory workmen, the expense of operating the department may be distributed on the basis of the total man hours worked in each department. However, many plants use number of time tickets handled as a basis for distribution.

**Powerhouse Expense**—Service performed by this department consists of producing steam used for:

- 1 Building heat
- 2 Power generation
- 3 Compressed air production

The expenses applicable to the powerhouse are collected independently of the remainder of the plant, as though the power division were a separate institution. Within the power division, expense accounts should be so arranged as to segregate the expenses for the three subdivisions mentioned above. Thus the rubber industry's Manual states:

For plants producing their own steam and power the most equitable basis of distribution is the demand basis. The demand basis is patterned after the method developed by public utilities whereby a minimum charge is made based upon the demand of each customer. Additional charges are made for actual consumption. This theory applied to manufacturing plants has the advantage of causing each department to stand its share of the fixed expense of a power plant. This expense is shared based upon the demand of the department under normal conditions. The remaining expense of the power plant is then distributed on the basis of actual consumption.

Similarly, distribution of power and allied accounts is discussed in the Steel Founders' Manual as follows:

**Z 1 Power and Light Purchased**—This account will cover the purchase cost of electric power and the expense of the transformer station. Distribution will be on the basis of kwh consumed in each department (productive auxiliary or service department). Kwh by departments will be obtained by metering or by multiplying normal load of each motor by operating hours.

**Z 2 Power Plant**—This account will cover indirect labor, fuel, water repairs, depreciation, taxes, insurance and floor space rental of the power plant. Distribution will be made on the basis of kwh consumed in each department as outlined for purchased power.

**Note** Where, in any one foundry, both purchased and produced power is used, the cost per kwh on each source should be computed for comparative purposes, but the two departments should be added together and prorated in a single distribution.

**Z 3 Heating Department**—The entire cost of this department, including fuel, water, taxes, depreciation and insurance, will be prorated over the various building rental accounts on the basis of cubic contents of departments receiving heating service in each building group with arbitrary modification where necessary.

**Note** In any case where more than one heating plant is operated, as for example, a separate heating plant for office building, a separate service department account should be carried.

(For additional discussion of power distribution, see later in this Section.)

**Purchasing Department Expense**—This department renders a service for all divisions of the plant by placing orders for raw materials and factory supplies, for factory and office equipment as well as supplies for the marketing and administrative divisions. Under these circumstances, the purchasing department expense should be distributed monthly among all divisions. The most equitable bases for distribution of purchasing department expense are as follows:

- 1 Value of purchase orders received
- 2 Number of purchase orders placed

The first basis requires an analysis of all invoices covered by purchase vouchers each month. The latter are analyzed as to departments for which materials, supplies, and equipment are purchased. The money value of the purchase vouchers so analyzed becomes the basis for the departmental expense distribution. Some cost accountants feel a more equitable distribution of purchasing department expense is on the basis



of the number of purchase orders placed. This basis likewise requires analysis of purchase orders placed during the month, in terms of departments in which the purchase requisitions originated. While these analyses require extra clerical work they provide a more accurate distribution of purchasing department expense than any other method. Direct labor hours is a basis often used, but its use is not recommended.

**Storesroom Expense**—This department renders a service to all departments which requisition raw materials and supplies including the marketing and administrative divisions. Hence, a portion of this service expense is prorated to the Marketing and Administrative Expense accounts at the end of each month. Bases used to distribute storesroom expense are as follows:

- 1 Number of stores requisitions filled
- 2 Number of stores items issued
- 3 Value of materials and supplies issued

The number of stores requisitions filled by the stores department is a fair basis for distribution of storesroom service expense, if a requisition is made out for each issue of raw materials from storesroom. This is usually the case where a job order cost system is in operation. However, in the case of continuous production, as for example in glass factories, blast furnaces, cement mills, etc., daily and monthly summary records of quantities issued are used in lieu of stores requisitions. The number of stores items issued is a more equitable basis for distribution of storesroom expense, particularly if the practice is to write more than one item on a stores requisition. Much of the cost of operation of a storesroom is identified with the issue of stores items and posting and pricing the requisitions after the issues have been made.

Where stores requisitions are not used as basis for issue the value of materials and supplies issued may be a better basis for distributing the storesroom expense. The Steel Foundries' Manual discusses the distribution of purchasing and receiving departments as follows:

**Z 19 Purchasing Department**—The entire cost of this department including direct expenses and its share of other service departments will be apportioned between the two storage departments Z 20 Receiving and General Stores and Z 22 Receiving and Storage of Metals and Manufacturing Supplies on the basis of the value of materials issued from these two stores departments during the current month.

**Z 20 Receiving and General Stores**—The expense of this department including direct charges fixed charges and its share of the foregoing service departments will be distributed over all productive, auxiliary, and remaining service departments on the basis of value of general stores materials consumed.

**Z 22 Receiving and Storage of Metals and Manufacturing Supplies**—The entire cost of this department, including direct charges fixed charges and its share of foregoing service departments, will be distributed over all productive and auxiliary departments on the basis of value of the metals and manufacturing supplies consumed.

The above method is in sharp contrast to that of the rubber manufacturing industry discussed earlier in this section. The rubber industry treats material handling charges as direct additions to material cost.

**Tabulating Expense**—Tabulations may be provided for production orders, stores inventory, finished stock inventory, cost of sales, raw materials and factory supplies issued, payroll and labor distribution, plant and service expense analysis, building and equipment ledger records, accounts payable, accounts receivable, and marketing cost analyses including sales, costs and expense analyses. Tabulation service expense is distributed at the end of each month to the manufacturing, marketing, administrative and financial divisions in accordance with the relative amount of service rendered to the respective divisions, as measured by the following bases:

- 1 Number of cards punched, sorted and tabulated
- 2 Tabulating machine hours
- 3 Specific allocation to department

Where a wide variety of tabulation is performed for all divisions of a business and for numerous departments of a manufacturing division, the most equitable basis for distribution of tabulating expense is by number of cards punched, sorted, and tabulated. Automatic counters on machines provide a count of tabulating cards. The number of hours each tabulating machine is operated for a specific department or division may be used as a basis for distributing this service expense. This plan requires that each machine operator keep a daily record of work performed on each machine, as it relates to different departments and divisions.

Where use of tabulating equipment is narrowed down to only one application, as for example, payroll and labor distribution accounting, distribution of this service expense is by specific allocation to either the payroll department or the factory accounting department.

**Testing Laboratory**—The testing laboratory performs a service, as a general rule for specific producing departments. In a foundry, tests are made for the melting department. In a steel plant, pig iron is analyzed from each run of the blast furnace, while the carbon content of steel is tested as it comes from each open hearth heat and Bessemer converter heat. Sometimes, the testing laboratory makes tests of raw materials received before they are accepted and placed in stock. The distribution of this service department expense is made on the following bases:

- 1 Units of productive output
- 2 Testing laboratory hours

The units of productive output basis provides a fair method of distributing this expense if the time required for testing is fairly commensurate with the volume of production in different departments. If this condition is not present, the testing laboratory hours may be used as a basis for distribution of this expense. The total testing department expense for the month is divided by the total number of hours worked by laboratory testers. This rate is then multiplied by the number of hours spent by laboratory technicians in making tests for specific departments. The Steel Founders' Manual, while recommending laboratory hours as a basis for laboratory expense distribution, also leaves the way open for other methods.

The entire expense of this department, including indirect labor (salaries), miscellaneous expense (chemicals, traveling, etc), repairs, fixed charges and its share of foregoing service departments, will be distributed over the various productive and auxiliary departments and the selling expense account "Sales Engineering Expense" on the basis of service rendered as expressed in laboratory hours or on an arbitrary basis representative of the general service rendered by this department.

**Timekeeping**—This department is frequently included with factory payroll service. In such case timekeeping expense is distributed on the same basis used to distribute factory payroll expense. Where timekeeping service is accounted for as a separate service department, the expense for its operation is distributed either on the basis of man hours or the number of employees.

The man hour basis seems a more equitable basis than the number of employees, where a large amount of overtime is worked in certain departments. The latter condition requires additional checking by timekeepers. The number of employees as a basis for distribution of timekeeping expense provides an equitable method where little or no overtime is worked and where the same amount of time is required by the timekeeper to account for the presence or absence of each employee.

**Toolroom Expense**—This department is custodian of all expensive hand tools not entrusted to the permanent possession of shop workmen and of all hand tools infrequently used. When tools are requested by factory workmen, they are required to present a tool check, with their employee number on it, in order that a running record is available to show in whose possession tools are at all times. This service is generally referred to as tool crib service. Sometimes the toolroom also engages in making small tools and dies, if a machine shop is not available. The expense of operating the toolroom is distributed on the following bases:

- 1 Direct labor hours
- 2 Specific allocation to departments or accounts

The direct labor hour basis for distributing toolroom expense is an equitable basis when the service consists exclusively of tool crib service. If toolroom renders service in form of tool or die making, a shop order should be issued to specify the character of work. Material and labor cost and a portion of the toolroom expense should be accumulated to each toolroom shop order. The latter, in turn, indicates the department or account number which should be charged for the accumulated cost.

**Transportation Service**—Plant transportation service is either external or internal. External transportation in the form of automobile truck transportation is provided in many industrial plants to transport freight and express for the stores and shipping departments. The expense of operating this department may be distributed on the following bases:

- 1 Automobile truck hours
- 2 Automobile truck miles
- 3 Tonnage hauled

Automobile truck hours as basis for distributing this type of expense involves the computation of an automobile truck hour rate. This rate is computed by dividing the total expense of operating this department by

the total number of truck hours operated. The expense is then distributed among departments by multiplying the automobile truck hour rate by the number of hours of service rendered to these departments. The record of hours worked is prepared by the operator of the truck. This is the method advocated by Steel Founders' Society.

Automobile truck miles may be used as an equitable basis for distributing trucking expense, particularly where long hauls are involved. Under this plan, it is necessary for the truck operator to keep a daily record of miles operated as they relate to services performed for different departments and divisions of the plant. The tonnage basis for distributing automobile service department expense provides a fair basis for distribution of this expense if a record is available or easily obtainable with respect to tonnage handled for each department.

The internal transportation system is used to transport materials and supplies from the storesroom to the producing departments, to carry scrap from a producing department to the storesroom or salvage yard, and to handle interdepartmental transfers of work in process and finished goods. The usual practice is to charge the storesroom for delivery of materials to producing department which utilizes them. Then, in turn, each producing department is charged with the expense of moving the work in process out of the particular department. In this manner, the producing department in which the last manufacturing operations are performed is charged with the expense for transferring the finished products or jobs to the finished stock warehouse or the shipping platform. The expense for the internal transportation service may be prorated on the basis of truck hours or tonnage hauled. The truck hour basis provides the easier plan for distributing this service expense, because time is obtained from the truck operators' time tickets showing the number of hours worked in each department. Weight of the materials transported however represents a more exact measurement of the cost of internal transportation. The difficulty involved in utilizing this basis is obtaining accurate weights on materials transferred.

The same method as outlined above is applicable in the case of traveling cranes. In this connection the Steel Founders' Manual states:

**Z 27 Traveling and Wall Cranes**—A separate account should be carried for each crane. The entire expense of this department including labor, repairs, taxes depreciation, insurance power etc., will be distributed among the various productive and auxiliary departments on the basis of service rendered. A summary record should be kept to accumulate separately the distribution of labor cost for each crane in hours and dollars. The operating hourly cost of each crane should be determined and applied to the record of service rendered by each.

**Waste, Sand, and Refuse Disposal**—The Steel Founders' Manual states:

This account including Labor Freight, its share of Drayage and Trucking and all other expense in connection with loading and removal of waste sand should be distributed over the various melted metals molding, and core departments on the basis of tons of sand or refuse removed from each.

**Water Pumping and Treating**—Some industrial enterprises which consume a large volume of water have their own water plants. Water is pumped from wells or from rivers and lakes. The total expense of operating this department each month is divided by the number of thou

sands of gallons of water pumped during the month in order to compute unit cost of water pumped. This cost is then applied to the quantities consumed in the several departments in order to effect an expense distribution. The most equitable basis for distribution of this service department expense is by use of water meters. Meters should be installed in each department where large volumes are consumed. Another meter should be provided to measure water used for drinking and wash-room purposes. The cost of water used for this latter purpose is usually charged to the building service department.

**Yard Switching Service**—This department renders a service primarily for the stores department and for the shipping department. This means that the expense of this department is distributed at the end of each month to both manufacturing and marketing divisions. The bases which can be used for the distribution of this service expense are

- 1 Switching hours
- 2 Number of cars handled
- 3 Tonnage handled

Under all three bases the unit cost of yard switching service is computed by dividing yard switching expense each month by the units to be used. The unit switching cost is then multiplied by the number of units of service rendered to each department and division in order to distribute the cost. The first and second of the above methods provide satisfactory bases for the distribution of yard switching service. However, tonnage handled usually does not provide a basis as adequate or expedient as the other two. The reason is that a special record of tonnage handled must be kept by the yard switchmen, and this in turn necessitates recording the weight of empty cars in addition to load weights. If "empties" are not included in the tonnage record, an accurate expense distribution cannot be provided.

## ✓ Procedure in Secondary Distribution

**DISTRIBUTING SERVICE DEPARTMENT EXPENSES DIRECTLY TO PRODUCING DEPARTMENTS**—Under this plan service department expenses are not distributed to other service departments, even though the services rendered by certain service departments are utilized by other service departments. Instead, the entire amount of expense of operating every service department is distributed directly to producing departments. This plan provides the simplest and quickest method for distributing expenses of service departments. The number of these secondary expense distributions, under this plan, is equal to the number of service departments, and the fewer the number of distributions, the more quickly they can be made.

Some cost accountants are of the opinion that greater accuracy of costs is obtained by minimizing distributions and that plant expenses representing direct charges to producing departments cannot be reflected accurately and equitably in product costs. This is illustrated in the Uniform Accounting Manual of the Rubber Manufacturers' Association.

It is desirable to limit as much as possible the distribution and redistribution of general factory expenses that is, the application of floor space

MANUFACTURING EXPENSE DISTRIBUTION											
FOR JANUARY 19--											
EXPENSE ACCOUNT			SERVICE DEPARTMENTS								
CODE	NAME	GRAND TOTAL	PRODUCING DEPT. FITTINGS	ENGINEERING	TOOLROOM	STORAGE ROOM	FACTORY ACCOUNTING	GENERAL PLANT	POWERHOUSE	SUB-TOTAL	
			500	51	52	53	54	55	56		
			MACHINING SHOP	FINISHING	HEAT TREATING	ASSEMBLY	SUB-TOTAL				
	T t t Direct Expense	\$17 911.71	\$139 157.67	\$ 9 857.96	\$ 7 7 7 70	\$ 5 979.54	\$50 811.71	\$ 3 396.60	\$ 3 850.00	\$ 2 100.00	\$12 000.00
	Service Department Expense b t t to t one										
5504-1	Heat		\$ 1 035.61	\$ 208.32	\$ 211.47	\$ 354.70	\$ 1 922.12				\$ 1 922.12
5504-2	L. oil		\$10.34	\$107.96	\$79.48	\$122.37	\$719.04				\$719.04
5504-3	Power		\$ 122.15	\$95.36	\$ 122.97	\$ 107.16	\$ 9 359.6				\$ 9 359.6
5505	General Plant		\$62.60	\$816.46	\$190.07	\$434.60	\$ 2 200.64				\$12 000.00
5506	Factory Accounting		\$51.60	\$79.46	\$157.06	\$412.60	\$ 2 100.60				\$ 2 100.00
5507	Storeroom		\$ 200.60	\$300.60	\$228.00	\$12.00	\$ 800.60				\$ 3 800.00
5508	Foolroom		\$ 634.60	\$ 534.00	\$246.00	\$14.00	\$ 709.60				\$ 3 700.00
5509	Eng. meeting		\$ 450.60	\$375.00	\$50.00	\$105.00	\$ 3 300.60				\$ 3 300.00
	T t t Serv. Expense b t t to t one		\$13 137.07	\$ 5 725.10	\$ 2 654.20	\$ 3 809.29	\$17 100.00				
	T t t Direct no fee at Producing Department Expense		\$14.00	\$70.54	\$68.90	\$ 0 799.20	\$ 8 242.20	\$ 7.11			\$ 7.11

Fig 7 Service Department Expense Distributions Made to Producing Departments Only

expenses to a nonproductive department and the reapplication of the expenses of this nonproductive department to productive departments.

It is also desirable to minimize the distribution of reciprocal elements, i.e. the application of the cost of heating to the cost of floor space when before the floor space can be charged to the power division the cost of heating will have to be ascertained and before the cost of heating can be ascertained the total cost of the floor space for the power division must be computed.

The various objections to elaborate distributions may be summarized as follows:

- 1 Service expenses are an unavoidable evil and the easiest distribution is also the best.
- 2 Accuracy of job and product costs is not enhanced.
- 3 A more confused mixture of expenses results from interdepartmental distributions.
- 4 For control purposes it is enough to know the service department expenses.

Under this first plan of distributing service department expenses, it makes little difference in what order the service department expense columns are arranged on the expense distribution sheet. Since there are no interdepartmental service distributions to be made, the service expenses are distributed to the producing departments in whatever order they are arranged on the distribution sheet. In Fig 7 the expense distribution sheet shows secondary distributions of manufacturing expenses. Departmental direct expense totals appearing on line 1 are the starting point in making secondary expense distribution and are taken from Fig 4. In practice the service department distributions usually appear on the same sheet as the primary distributions.

**SECONDARY DISTRIBUTIONS ON NONRECIPROCAL BASIS**—By this plan, cognizance is taken of the fact that services rendered by certain service departments are in part utilized by certain other service departments and distributions are made accordingly. Under the nonreciprocal basis there is no two-way distribution of expenses between two service departments. This means, for example, that a portion of power plant expense is distributed to the toolroom because the power plant provides a service to the toolroom. But, in turn, no part of toolroom expense is distributed to the power plant even though the toolroom actually rendered some service to it.

There are two principal arguments for using this plan:

- 1 Failure to charge a given service department with the cost of services rendered by other departments causes an understatement of cost of operating the department receiving the service.
- 2 If expenses of each service department are controlled through the use of budgets the cost of services rendered to it by other service departments should be incorporated in the departmental budgets. Only by so doing can efficiency of operation of a particular service department be measured.

The principal arguments against this plan are that a greater amount of work is entailed in its use and that no increase in accuracy of costs is secured. In the illustration below the procedure followed under this method is demonstrated.

**Cost of Steam Produced**—The number of thousands of pounds of steam produced during the month is determined from meter readings, these meters measure the flow of steam to the building heating lines, to steam power turbines, etc. Readings of all meters are taken at the beginning and end of each month. The total expenses for the month incurred in steam production are divided by number of thousands of pounds of steam produced which gives a unit cost per thousand pounds of steam. The steam consumption of building heat lines, etc., is then multiplied by the unit cost to determine the steam cost for these respective purposes.

The first step to analyze powerhouse expense in an auxiliary record as to expenses incurred in producing steam and in generating power, is as follows:

Code	Name	Total Expense	Boiler Room	Engine Room
501	Factory Supplies			
502	Small Tools			
504	Fuel			
505	Water			
507	Repair Materials			
508	Repair Labor			
510	Workmen's Compensation Insurance			
511	Social Security Taxes			
514	Service Attendants			
531	Departmental Heads and Assistants			
532	Depreciation Buildings			
533	Depreciation Equipment			
534	Insurance Buildings			
535	Insurance Equipment			
536	Taxes Building			
537	Maintenance, Buildings			
	<b>Totals</b>	<u>\$12 000 00</u>	<u>\$7 777 00</u>	<u>\$4 928 00</u>

(Detailed figures purposely omitted)

The cost department is given a copy of the monthly steam meter readings record. This is used to compute the unit cost of steam produced and the cost of steam allocated to steam heat and to power. Readings taken from steam meters for month disclose the total amount of steam produced as shown below:

	Meter Readings		Pounds of Steam Produced
	Steam Heat Line	Power Line	
End of month	91,199 00	76 084 90	
Beginning of month	84 671 00	56 198 41	
Steam produced	6,528 00	19 886 49	26 415 09
Boiler room expense			<u>\$ 7 777 —</u>
Cost per 1,000 lbs of steam	\$ 294415	\$ 294415	
Allocation of steam expense to			
Steam heat	\$ 1 922 12		
Electric power		\$ 5 854 88	

**Steam Heat Expense**—The cost of steam measured to the building heat lines is, in turn, distributed to various departments utilizing heat on one of the following bases:



- 1 Cubic content
- 2 Radiation surface
- 3 Area basis

Where there is a considerable discrepancy in the height of ceilings in various departments, the cubic content basis is better. Where the height of ceilings is uniform, methods 1 and 3 yield the same result, but since area is easier to calculate it is preferable. If the heat charge is distributed on the basis of the square feet of radiation, the result approximates method 1, since engineers take into account the height of the ceiling, etc., in prescribing the size of radiator to be installed. In this illustration the total steam heat expense is distributed on the basis of the cubic content of all departments, exclusive of the powerhouse, since the latter is the account being distributed.

## MONTH OF JANUARY 19\_\_

Department	Cubic Content	Per Cent of Total	Distribution
90	1,600 000	44%	\$ 845 73
91	416 000	12	230 65
92	320 000	9	172 90
93	480 000	13	249 88
01	256 000	7	134 55
02	128 000	3	57 67
03	315 000	9	172 99
04	70 000	2	38 44
05	42 000	1	19 22
	<u>3 627 000</u>	<u>100%</u>	<u>\$1 922 12</u>

**Cost of Electric Power Generated**—The cost of electric power generated consists of the total power expenses plus a share of the boiler room expenses. In the present illustration the total cost of power generated is summarized on a computation sheet as shown below.

## MONTH OF JANUARY, 19\_\_

Total expenses of generating electric power exclusive of cost of steam (see page 994)	\$ 4 223 00
Total cost of steam allocated to generation of electric power (see page 994)	<u>5 854 88</u>
Total cost of electric power generated	\$10 077 88
Total kwh of electric power generated	560 000
Cost per kwh	\$ 017996

The electric energy produced is distributed each month to two separate lines, as follows:

- 1 Power circuit for machinery and equipment
- 2 Lighting circuit for buildings and yard

The distribution takes place on the basis of meter readings as follows:

Allocation of electric power generated to		
Building light circuit	40 000 kwh @ \$ 017996	\$ 719 84
Machinery power circuit	520 000 kwh @ 017996	<u>9 358 04</u>
Total power cost	560 000 kwh @ 017996	<u>\$10 077 88</u>

**Electric Light Expense**—The lighting circuit for an entire building is usually on a single meter, so that total kilowatt-hour consumption

for lighting can be definitely measured each month. Distribution to departments may be made as follows:

- 1 Departmental floor area
- 2 Engineering estimates
- 3 Number of outlets
- 4 Kilowatt hour

The area basis provides a very simple method for the distribution of electric light expense. However, this basis may result in inaccurate and inequitable charges to different departments. Departments which have ample skylights and large side windows do not need as much light as departments which do not have as much natural light. The limitation of the area basis is that it does not take into account the intensity of light usage. A fairer basis for distribution of light expense may be by engineering estimates. These are based upon three factors:

- 1 Number of electric lights in a given department
- 2 Wattage of the bulbs
- 3 Number of hours the lighting circuit is in use each month

An estimate of this nature requires more time to compute, but provides a more accurate distribution of light expense than does an area basis. The latter provides the following distribution:

MONTH OF JANUARY 19__			
Department	Floor Area	Per Cent of Total	Distribution
90	100 000	42%	\$302 33
91	26 000	11	79 18
92	20 000	8	57 50
93	30 000	12	86 38
01	16 000	7	50 39
02	8 000	3	21 60
03	26 250	11	79 18
04	8 750	4	28 79
05	5 250	2	14 40
	<u>240 250</u>	<u>100%</u>	<u>\$719 84</u>

**Electric Power Expense**—The power line used to deliver current to machinery and equipment should be on a separate meter from circuit required for lighting building. The monthly estimate of departmental kilowatt hour consumption for power is made on the basis of daily meter readings. Electric power expense is distributed upon different bases to departments where it is consumed:

- 1 Departmental electric power meters
- 2 Specific machine meters
- 3 Horsepower ratings of motors

Use of separate meters to measure consumption of power in each department is one of the best ways to distribute electric power expense. Where large machines require heavy duty motors to operate them, and where machine hour burden rates are used as a method of applying burden to production, the more modern industrial concerns install separate electric meter for each large machine. In many plants individual or even departmental electric power meters are not available. Under these circumstances, an estimated distribution of power expense

[illegible]

FIG 8 Service Department Expense Distributions Made to Producing and Service Departments on a Nonreciprocal Basis

is made. The estimated or actual number of hours that a machine is operated is multiplied by the horsepower rating of the motor in order to arrive at the horsepower hours of electric power consumed. A summary of these computations made by the engineering department, for all motors in a given department, provides the total estimated horsepower hour consumption for the department.

An alternative method where a power line is not provided with departmental meters is to distribute power on the basis of direct labor hours worked or machine hours operated in those departments. Both bases may provide an inequitable distribution of power expense. In the case of the direct labor hour basis some direct labor hours worked may represent hand work that bears no relation to the number of kilowatt hours of power consumed. The machine hour basis may also provide an inequitable departmental distribution of power purchased if different machines require different power loads or do not operate for the same number of hours. The distribution below is on the basis of kilowatt hour consumption.

MONTH OF JANUARY 19__			
Department	Kwh Consumed	Cost per Kwh	Distribution
90	380 000	\$ 017996	\$6 838 57
91	50 000	017996	898 81
92	60 000	017996	1 079 77
93	10 000	017996	179 96
02	20 000	017996	359 93
	<u>520 000</u>		<u>\$9 358 04</u>

**General Plant Expense**—The distribution of general plant service is based upon the total man hours worked in the producing and service departments, exclusive of the powerhouse and general plant service. The expense distribution sheet (Fig 8) shows general plant expense of \$2,233 62 to be distributed. It is a total made up of two different types of charges:

- 1 \$2 200 represents direct charges to general plant service
- 2 \$33 62 is total indirect charge distributed from the power department

The distribution of general plant service expense is shown below:

MONTH OF JANUARY 19__			
Department	Total Man Hours	Per Cent of Total	Distribution
90	26 300	28%	\$ 625 41
91	32 300	34	759 43
92	7 500	8	178 69
93	18 400	20	446 73
01	2 200	2	44 67
02	1 900	2	44 67
03	4 000	4	89 35
04	2 000	2	44 67
	<u>94 600</u>	<u>100%</u>	<u>\$2 233 62</u>

**Factory Accounting Expense**—The factory accounting department is distributed on the basis of total man hours worked in the producing departments and service departments, exclusive of the powerhouse, gen-

eral plant office, and factory accounting office. The total factory accounting expense to be distributed in this illustration is \$2,211.90. This total represents direct charges to factory accounting of \$2,100 and indirect charges of \$111.90, which were distributed from the powerhouse and general plant service departments (see Fig. 8). The computation for distribution of factory accounting expense is presented below:

## MONTH OF JANUARY 19\_\_

Department	Total Man Hours	Per Cent of Total	Distribution
90	26 300	29%	\$ 641.45
91	32 300	35	774.16
92	7 500	8	176.95
93	18 400	20	442.38
01	2 200	2	41.24
02	1 900	2	44.24
03	4 000	4	88.48
	<u>92 600</u>	<u>100%</u>	<u>\$2 211.90</u>

**Storesroom Expense**—Storesroom expense distribution is based upon the value of stores issued on requisitions to the producing departments and to the toolroom. The amount to be distributed is \$4,230. This total represents direct charges of \$3,800 for storesroom service, and indirect expense distributions of \$430 made from the powerhouse, general plant office, and factory accounting office.

## MONTH OF JANUARY 19\_\_

Department	Value of Stores Requisitioned	Per Cent of Total	Distribution
90	\$ 92 097.39	60%	\$2 538.00
91	15 997.68	10	423.00
92	9 815.42	6	253.80
93	36 868.60	23	972.90
02	491.70	1	42.30
	<u>\$154 770.79</u>	<u>100%</u>	<u>\$4 230.00</u>

**Toolroom Expense**—This expense is distributed to producing departments on the basis of direct labor hours. The toolroom expense total of \$4,270.41 is composed of direct expenses of \$3,700, and \$570.41 of service expenses distributed from powerhouse, general plant office, factory accounting office, and storesroom.

## TOOLROOM DISTRIBUTION

## MONTH OF JANUARY 19\_\_

Department	Direct Labor Hours	Per Cent of Total	Distribution
90	20 000	28%	\$1 195.72
91	30 000	42	1,793.57
92	6,000	8	341.63
93	16,000	22	939.49
	<u>72 000</u>	<u>100%</u>	<u>\$4 270.41</u>

**Planning and Production Control**—This expense is distributed to producing departments on the basis of the number of items specified on production orders. The total engineering expense of \$3,573.85 comprises

\$3,300 of direct charges and \$273.85 of indirect expenses distributed from powerhouse general plant office, factory accounting office, and stores room service

Computation for distribution of planning and production control expenses is as follows

MONTH OF JANUARY 19__			
Department	Items on Production Orders	Per Cent of Total	Distribution
90	4 000	50%	\$1 786 93
91	2 000	25	893 46
92	800	10	357 39
93	1 200	15	538 07
	<u>8 000</u>	<u>100%</u>	<u>\$3 573 85</u>

**Arrangement of Work Sheet**—When service department expense distributions are made to other service departments on a nonreciprocal basis, the arrangement of service department columns on the expense distribution sheet must be carefully planned. Those service departments which provide the greatest number of distributions to other service departments should be placed at the extreme right-hand side of the distribution sheet. In passing from right to left on the work sheet, each service department has at least one less distribution than the column on its right, that is, expense distributions are made in column order from right to left in stepping stone fashion. As soon as each distribution is computed, it is posted to the expense distribution sheet, thus closing out a specific departmental column. The next column immediately to the left is then totaled and this total is used in making a distribution to any or all departmental columns to the left. When all service departments have been thus distributed, the producing department columns are subtotaled, and the subtotals are added to the subtotal of the direct charges to obtain the grand totals (Fig. 8). Naturally the results under this method are different from those obtained under the prior method because in this instance a portion of service department costs is absorbed by other service departments.

The Steel Founders' Society of America, Inc., in its Uniform Accounting and Cost Plan for Steel and Alloy Foundries, recommends to its members the use of a departmental expense distribution sheet. Because of its size, only a section is shown in Fig. 9. It is known as an apportionment distribution sheet, and its purpose is the accumulation and distribution of service department expenses. Hence, the names of service departments appear both horizontally and vertically. The horizontal figures show debits to service department accounts listed at the left. Vertical figures represent distributions of, i.e., credits to, accounts listed at the top of the various columns. Note that the horizontal and vertical arrangements are the direct opposites of the more common arrangement previously shown in this Section. Fig. 9 shows the departmental accounts appearing down the left-hand side of the apportionment sheet. These include the service departments, productive and so called auxiliary departments and finally selling and general administrative expenses.

Across the top of the work sheet after the "Original Trial Balance

AC NO	ACCOUNT	ORIGINAL TRIAL BALANCE	PURCHASED AND PRODUCED POWER		HEATING DEPT	
			K W H	AMOUNT	CU FT HEATED	AMOUNT
Service Departments						
1	Power and light purchased	\$ 170 00		\$170 00		
1 2	Power Plant	447 00		715 00		
			44 161	\$685 40		
2 3	Heating department	000 00	150	\$ 3 01	300 000	\$903 11
4 4	Floor space rental off co bldgs	06 00	400	8 02	35 000	\$104 01
2 5	Floor space rental fdy bldg	320 00	600	12 05	120 000	\$365 06
6	Floor spa e rental fdy bldgs	397 00	600	12 05	107 000	\$334 05
7 10	Grayside and trucking	415 00				
1 11	Worship anagone l	1 014 00	100	2 00		
1 12	General supervision	9 9 00	100	2 00		
1 13	General supervision	484 00	100	2 00		
1 14	General supervision	104 00	100	2 00		
2 15	Cost Department	750 00	200	4 01		
2 16	Cost Department	646 00	100	2 00		
2 17	Safety and dispensary	562 00	100	2 00		
	Total labor hour basis					
28	Laboratory	850 00	200	4 01		
2 19	Receiving department	562 00	100	2 00		
2 20	Receiving and general stores	397 00	200	4 01		
2 21	Receiving and general stores	714 00				
2 22	Receiving and general stores	1 249 00				
2 23	General supervision	847 00				
2 24	Repair and maintenance department	1 306 00	800	16 04		
2 25	Pattern storage	572 00	100	2 00		
2 26	Pattern storage	93 00				
2 27	Traveling and wall cranes	2 842 00	1 563	27 55		
2 28	In position department	907 00				
2 29	Compressor department	164 00	467	9 56		
2 30	Waste sand and refuse disposal	346 00				
	Total service departments	\$17 900 00	5 820	\$116 45	300 000	\$903 11
Direct Productive Departments						
12	Molding large dry sand flask castings		2 810	46 36		
13	Molding small dry sand castings		4 126	62 74		
42	Molding green sand floor castings		7 200	145 16		
General Productive Departments						
W 1	Pattern shop		395	7 42		
W 2	Open hearth furnace A		1 406	28 23		
W 3	Open hearth furnace B		912	16 29		
W 4	Electric furnace A		3 070	61 55		
W 5	Electric furnace B		1 892	37 93		
W 6	Alloy furnace		127	2 55		
W 11	Coke making dry sand		960	19 25		
W 12	Coke making green sand		717	14 37		
W 16	Cleaning and finishing		12 046	241 40		
W 16	Residue heat treating		306	6 15		
W 16	Special heat treating		66	1 40		
Auxiliary Departments						
1 1	Dry sand mill		800	9 82		
1 2	Green sand mill		267	5 75		
1 3	Coke sand mill		104	2 09		
1 5	Dry sand mold ovens		375	11 53		
1 6	Ladle coat (ball ladle)					
1 7	Ladle coat (shank ladle)					
	Total serv dept chgs to fdy					
Selling Expenses						
	Sales department		100	2 00		
	Sales order		100	2 00		
	Shipping		300	6 02		
	Undistributed		200	4 01		
General Expense						
	Executive offices		100	2 00		
	Accounting		100	2 00		
	Cashier					
	Billing		100	2 00		
	Undistributed		200	4 01		
	Total charges to sell and Gen Exp		44 161	\$685 40	300 000	\$903 11
	Total		02005		00301	
	Rate for the month					
	Rate applied after preliminary distributions					

FIG 0 Expense Distribution Sheet

Column," headings appear for all accounts from Z 1 to Z 30, also a column for "Total Service Department Charges." Each column is subdivided into two parts to show the quantitative factor on the basis of which it is distributed (kwh cu ft etc.), and the dollar amount. This requires a huge work sheet. The Manual therefore suggests that in actual practice it is preferable to use smaller work sheets splitting up the work among several sheets to be summarized at the end.

The specific columnar headings and their subdivisions are as follows

1 Original trial balance	11 Receiving and storing—materials and supplies
2 Purchased and produced power	a Value of materials consumed
a Kilowatt hours	b Amount
b Amount	12 General engineering
3 Heating department	a Engineer hours
a Cubic feet heated	b Amount
b Amount	13 Repair and maintenance
4 Floor space rental accounts	a Repair labor hours
a Office buildings	b Amount
b Foundry buildings—group A	14 Pattern storage
c Foundry buildings—group B	a Square feet occupied
(Each of these is subdivided into square feet and amount)	b Amount
5 Drayage and trucking	15 Fuel oil storage
a Truck hours	a Gallons consumed
b Amount	b Amount
6 Accounts Z 11 to Z 17	16 Traveling and wall cranes
a Labor hours	a Crane men's hours
b Amount	b Amount
7 Laboratory	17 Inspection
a Labor hours	a Loss on defectives
b Amount	b Amount
8 Purchasing department	18 Compressor
a Value of materials issued	a Square inches of outlets
b Amount	b Amount
9 Receiving and general stores	19 Waste and disposal
a Value of materials issued	a Tons removed
b Amount	b Amount
10 Locomotive cranes	20 Total service department charges
a Crane operating hours	
b Amount	

Use of this form is described in the Manual as follows

#### EXPLANATION FOR OPERATION OF APPORTIONMENT DISTRIBUTION SHEETS

1 The trial balance of service department expenses will be entered in the first amount column and totaled

2 Insert figures representing factors for distribution in the first half of each double column

3 Apportion the trial balance of the first service department to be distributed over the various departments receiving service as shown in the factor column entering the respective amounts in the amount column opposite the factor figures. Apportionment of departments should follow the sequence in which they appear from top to bottom on the form

4 Cross total each department as shown on each succeeding line of the form, including with the trial balance amount any charge received from the prior service departments



For example on the horizontal line opposite Z 3 we have the following amounts

Original trial balance	\$880 00
Plus amounts received from	
Power	3 01
Floor space rental	8 00
Departments Z 11 through Z 17	12 10
Total	<u>\$903 11</u>

Enter this total at the intersection of the horizontal and columnar division representing this department. Below the line distribute this cumulative total from top to bottom in proportion to the factors entered in the first half of this column under this same department heading.

5 Continue this process of distributing the charges accumulated against each successive service department to productive department or to service departments lower in the list. Finally all service department charges will in this manner be distributed among the productive departments.

6 It will be noted that under this method the service departments at the beginning of the list are not in a position to receive charges from those at the end of the list. The order has been so arranged however that those receiving the least service from others are disposed of first so that the total expense of each as shown by the cross totals may be considered its total cost. There are two exceptions however which should be recognized as indicated in the following two paragraphs.

7 Charges for floor space rental should be made to the preceding departments viz, power plant and heating departments when the amount involved warrants. For this purpose the previous month's cost rate per square foot should be used. The factors and amounts should be entered on the correct horizontal lines and the totals shown in red at the intersection of the floor space rental account horizontal line and vertical column. Figures in circles indicate red. When the floor space rental total is ready for distribution these figures should be deducted.

8 Another service department distribution which should make a preliminary charge to preceding service departments is the group beginning with works manager and general superintendence. For this group of departments a charge based on labor hours at last month's rate should be made to the preceding departments floor space rental, power plant and drainage and fueling. The total of these preliminary distributions should be entered in red and deducted from the total to be distributed as outlined in the previous paragraph.

9 The proof of clerical accuracy will be that the total service department charges finally accumulated against productive departments and auxiliary departments plus the amounts apportioned to general administrative and selling expense must agree with the total of service department trial balance. Proof of totals of service department charges for redistribution will be obtained by comparing the cross total of the subtotals under service departments with the vertical total of the individual service department cross totals as shown in the last column.

In steps 7 and 8 distributions are made to preceding departments on the basis of the rate established for the prior month. This is done in order to avoid a vicious circle (see description below).

## SECONDARY DISTRIBUTION ON A RECIPROCAL BASIS

—Under this method, it is recognized that services rendered by certain service departments are, in part, utilized by certain other service depart-

ments Hence, where two or more service departments render service to each other, a vicious circle is created in ascertaining the amounts to be distributed to each other The term "vicious circle" is applied to this type of problem, because where two departments, A and B, are interdependent it is impossible to know total expense of A until the distribution of B is complete but B's distribution cannot be made until it has received its share of A's expense

Arguments for using this method for secondary expense distribution of service department expenses are

- 1 If a given service department receives service from another department the department receiving such service should be charged for it And if in the case of two service departments each provides service to the other, each department should be charged for the cost of service rendered by the other
- 2 The full operating expense of a service department cannot be known unless it is charged with both direct expenses resulting from the primary expense distribution and all indirect expenses arising from secondary expense distributions This includes all interdepartmental service expense transfers
- 3 Control of service department expenses includes budgeting of both direct charges and interdepartmental service expense transfers

There are two arguments against use of this method

- 1 It involves more work than either of two preceding plans
- 2 It is doubtful whether it provides any more accurate product costs

When service department expense distributions are made to other service departments on a reciprocal basis, no particular arrangement of service department columns need be provided on the expense distribution sheet Those departments not included in the vicious circle are distributed first, other department expenses are then computed from work sheets or other devices The bases used in service department distributions under this plan are the same as those shown in earlier plans

**Powerhouse Service**—The table below shows a summary of power costs taken from the earlier illustration The grand total figures for steam light and power in each department are reduced to percentages of the total power cost

MONTH OF JANUARY 19\_\_

Department	Steam Heat Expense	Light Expense	Power Expense	Grand Total	Per Cent of Total
90	\$ 845 73	\$302 33	\$6,838 57	\$ 7 980 63	68.6%
91	230 65	79 18	899 81	1 209 64	10.1
92	172 99	57 59	1 079 77	1 310 35	10.9
93	249 88	88 38	179 96	516 22	4.3
01	134 55	50 39		184 94	1.5
02	57 67	21 60	359 93	439 20	3.7
03	172 99	79 18		252 17	2.1
04	38 44	28 79		67 23	.6
05	19 22	14 40		33 62	.3
Total Service Expense	<u>\$1 922 12</u>	<u>\$719 84</u>	<u>\$9 358 04</u>	<u>\$12 000 00</u>	<u>100.0%</u>

**Other Service Departments**—The same procedure is followed in the case of other service distributions In each case the distribution base

is reduced to a percentage of the total. For example, where man hours are used as a basis for distribution, such man hours are expressed as a percentage of total man hours, etc. In this way, the information shown below is obtained.

The general plant service is distributed on the basis of total man hours worked in all other departments, including the powerhouse. The same basis is used to distribute the Factory Accounting Service, namely, total man hours worked in all producing and service departments exclusive of factory accounting.

## GENERAL PLANT SERVICE DISTRIBUTION

Department	Total Man Hours	MONTH OF JANUARY 19__
		Per Cent of Total
90	26 300	26.9%
91	32 300	33.0
92	7 500	7.7
93	18 400	18.8
01	2 200	2.3
02	1 900	1.9
03	4 000	4.1
04	2 000	2.0
06	3 200	3.3
Total Man Hours	<u>97 800</u>	<u>100.0%</u>

## FACTORY ACCOUNTING DEPARTMENT

Department	Total Man Hours	MONTH OF JANUARY 19__
		Per Cent of Total
90	26 300	27.0%
91	32 300	33.2
92	7 500	7.7
93	18 400	18.9
01	2 200	2.3
02	1 900	2.0
03	4 000	4.1
05	1 000	1.6
06	3 200	3.2
Total Man Hours	<u>97 400</u>	<u>100.0%</u>

## STORES DEPARTMENT DISTRIBUTION

Department	Value of Stores Requisitioned	MONTH OF JANUARY 19__
		Per Cent of Total
90	\$ 92 097.39	59.3%
91	15 997.68	10.7
92	9 815.42	6.2
93	36 368.60	23.4
02	491.70	.3
06	599.75	.4
Value of Stores Issued	<u>\$155 370.54</u>	<u>100.0%</u>

Summary of Interdepartmental Service Expense Distributions—  
Fig. 10 summarizes the percentages of service department distributions as between charges to be made to producing departments and those to

PERCENTAGE DISTRIBUTIONS TO BE MADE TO SERVICE DEPARTMENTS							
	Producing Depart- ments	Engi- neering	Tool room	Stores	Factory Account- ing	General Plant	Power house
01 Engineering	100.0%	x					
02 Toolroom	100.0		x				
03 Storesroom	99.3		4%	x			3%
04 Factory Accounting	86.8	23%	20	41%	x	16%	3.2
05 General Plant Service	86.4	23	19	41	20%	x	3.3
06 Powerhouse	91.8	15	37	21	6	3	x

FIG 10 Summary of Percentage Distributions of Service Departments

Fig 10 Summary of Percentage Distributions of Service Departments

MONTH OF JANUARY 19\_\_

	Percentages (Fig 10)	1st Trial	2nd Trial	3rd Trial	4th Trial
03 Storeroom Service Department		\$ 3 800 00	\$ 3 800 00	\$ 3 800 00	\$ 3 800 00
From 04 Factory Accounting	41%	86 10	90 88	90 95	90 95
05 General Plant	41	90 20	93 05	93 15	93 15
06 Powerhouse	21	252 00	235 18	255 33	255 33
		\$ 4 228 30	\$ 4 239 09	\$ 4 239 43	\$ 4 239 43
04 Factory Accounting Service Department		\$ 2 100 00	\$ 2 100 00	\$ 2 100 00	\$ 2 100 00
From 05 General Plant	20	44 00	45 39	45 44	45 44
06 Powerhouse	6	72 00	72 91	72 95	72 95
		\$ 2 216 00	\$ 2 218 30	\$ 2 218 39	\$ 2 218 39
05 General Plant Service Department		\$ 2 200 00	\$ 2 200 00	\$ 2 200 00	\$ 2 200 00
From 04 Factory Accounting	16	33 60	35 46	35 48	35 49
06 Powerhouse	3	36 00	36 45	36 43	36 48
		\$ 2 269 60	\$ 2 271 91	\$ 2 271 97	\$ 2 271 97
06 Powerhouse Service Department		\$12 000 00	\$12 000 00	\$12 000 00	\$12 000 00
From 03 Storeroom	3	11 40	12 72	12 72	12 72
04 Factory Accounting	32	67 20	70 99	70 99	70 99
05 General Plant	33	72 60	74 97	74 98	74 98
		\$12 151 20	\$12 158 68	\$12 158 60	\$12 158 69

FIG 11 Work Sheet of Service Department Expense Distributions by Trial and Error Method

be made to other service departments. The figures are taken from the schedules shown above. The vertical column figures show debits to the account indicated at the top of a column. These are in addition to direct charges already in the departmental accounts. The horizontal figures show distributions of service department accounts at the left of the table, and constitute credits to these accounts.

**METHODS FOR SOLVING RECIPROCAL DISTRIBUTIONS**—Three methods for making the necessary computations are available:

- 1 Trial and error method
- 2 Method of continued distribution
- 3 Method of simultaneous equations

Under the trial and error method, the object is to determine by successive trials, the total of each service department account before distribution, the total includes allocations from other service departments. Under the method of continued distribution, each service account is distributed by successive trials until the remaining balances are so small that further distribution may be disregarded. Solution by simultaneous equations may be profitably employed where calculating machines are available, and no more than three or four mutually interdependent accounts exist.

**Trial and Error Method**—This is an expedient method to use where there are more than two or three service departments affected by interdepartmental transfer of services. As shown in Fig 11, the amount of primary expense of each service department is the starting point in this computation. For example, the totals of direct expenses charged to service departments affected by the interexchange of department services are as follows:

	Primary Expense
03 Storesroom	\$ 3 800 00
04 Factory Accounting	2 100 00
05 General Plant Service	2 200 00
06 Powerhouse	12 000 00

In computing expense distributions under this method the following steps are involved:

1 Enter the primary expense totals of each service department involved in the vicious circle in the first trial column (Fig 11), allowing sufficient space under each service department to show the percentage of additional expense allocated from other service departments. An example follows:

	First Trial
03 Storesroom (primary expense)	\$3 800 00
Service furnished to Storesroom by	
04 Factory Accounting (41%)	
05 General Plant (41%)	
06 Powerhouse (21%)	

2 Multiply the primary expenses of the service departments which furnish the services by the percentage figures of their respective department.

	Second Trial
03 Storesroom (primary expense)	\$3 800 00
Services furnished to storesroom by:	
04 Factory Accounting ( $4\% \times \$2\ 100$ )	88 10
05 General Plant ( $4\% \times \$2\ 200$ )	90 20
06 Powerhouse ( $2\% \times \$12\ 000$ )	252 00
Service department expenses distributed by first trial	\$ 428 30
Total new storesroom expense after first trial distribution	<u>\$4 228 30</u>

3 After the first trial distributions of all interdependent departments are completed, the process is repeated by multiplying the new expense totals by the same percentage figures as before. The new products are then added to the original primary expense totals. An example follows:

	Second Trial
03 Storesroom (primary expense)	\$3 800 00
Services furnished to storesroom by:	
04 Factory Accounting ( $4\% \times \$2\ 216$ )	\$ 90 86
05 General Plant ( $4\% \times \$2\ 269\ 60$ )	93 05
06 Powerhouse ( $2\% \times \$12\ 151\ 20$ )	255 18
Service department expenses distributed by second trial	\$ 439 09
Total new storesroom expense after second trial distribution	<u>\$4 239 09</u>

4 Continue similar successive trial distributions until there is no difference between the totals of the last and the next to the last trial distributions.

The completed expense distributions, of those service departments affected by interdepartmental transfer of services, are shown in Fig 11.

**Method of Continued Distribution**—This method consists of closing and reopening the departmental service accounts by successive distributions. The steps involved are as follows:

- 1 Apply the given percentage to prorate the primary total in the first service department. This closes the account and charges the prorated amounts to other departments.
- 2 Apply the given percentages to the second service department whose total is made up of primary accounts plus proration from service department No 1. This closes the second department and charges the others including, perhaps No 1.
- 3 Apply the same procedure to all other service departments.
- 4 Repeat a second cycle of operations beginning with department No 1, whose total consists at present only of amounts prorated from other service departments. In this way the service department totals become less and less with each cycle of distributions.
- 5 Stop the process at any point where it is felt the resulting figures are too small to be of any consequence.

The entire procedure is illustrated in Fig 12. To prove the accuracy of the distributions, add the totals of columns 7 to 11 inclusive. They total \$27,100, which is equal to the total primary charges before any distributions are made. To arrive at the total debits in the service department accounts after all redistributions have been made simply add the various subtotals in each of the first four columns of Fig 12. The resulting totals, on page 1013, agree with those of Fig 11.





	(1) 90 MACHINE SHOP	(2) 91 FINISHING	(3) 92 HEAT TREATING	(4) 93 ASSEMBLY	(5) 94 SUB-TOTAL	(6) 95 ENGINEER- ING	(7) 96 TOOLING	(8) 97 STORAGE	(9) 98 FACTORY ACCOUNTING	(10) 99 GENERAL PLANT	(11) 00 POSTPAID	(12) 01 SUB-TOTAL	(13) 02 GRAND TOTAL
T 1st Primary Charges	519 187 67	5 8 109 86	5 7 744 76	5 5 679 5	558 081 7	5 3 306 08	5 3 708 60	5 3 400 00	5 2 300 00	5 2 200 00	512 600 00	527 100 00	577 911 71
Service Department Distributions													
Storeroom	2 513 98	426 66	267 08	972 05	4 269 75		16 96				12 72	29 68	4 299 43
Factory Accounting	516 96	756 51	170 52	419 28	1 852 27	51 67	84 37	90 05		35 80	70 99	292 82	2 213 39
General Plant Expense	611 16	749 75	174 90	827 13	3 761 91	5 25	43 37	59 15	85 84		78 90	208 99	3 271 07
Powerhouse Expense	8 055 53	3 228 09	1 301 30	532 02	11 161 48	252 30	449 07	253 30	72 95	216 09		997 01	12 150 69
Engineering	1 792 80	996 81	358 37	557 88	3 585 45								3 585 45
Toolroom	1 191 22	1 765 84	3 0 35	915 94	298 37								4 254 37
Total Secondary Charges	14 795 68	5 334 28	2 497 86	3 305 04	27 10' 60	285 65	554 37	439 05	118 59	71 97	158 69	1 618 53	28 720 50
Total Departmental Expenses	685 861	5 151 69	51 351 36	5 6 37 65	157 931 71	5 3 555 65	5 8 256 37	5 2 259 47	5 218 37	5 271 97	512 158 69	1508 7' 60	

Fig 13 Service Department Distributions to Producing and Service Departments on Reciprocal Basis

	Storesroom	Factory Accounting	General Plant Service	Power
Total from Cycle I	\$3 800 00	\$2,100 00	\$2 233 60	\$12 152 31
Total from Cycle II	432 88	117 58	38 34	6 33
Total from Cycle III	6 52	81	03	05
Total from Cycle IV	03			
Final totals	<u>\$4 239 43</u>	<u>\$2 218 39</u>	<u>\$2 271 97</u>	<u>\$12 158 09</u>

**Solution by Simultaneous Equations**—From the expense distribution table (Fig 10), a series of simultaneous equations can be formulated as follows

- (1) Let  $a$  = Storesroom expense including allocations from other departments
- (2) Let  $b$  = Corresponding factory accounting office expense
- (3) Let  $c$  = Corresponding general plant office expense
- (4) Let  $d$  = Corresponding powerhouse expense
- (5) Then  $a = \$ 3 800 + 041b + 041c + 021d$
- (6)  $b = 2 100 + 020c + 006d$
- (7)  $c = 2 200 + 016b + 003d$
- (8)  $d = 12 000 + 003a + 032b + 033c$

#### Transposing

- (9)  $a - 041b - 041c - 021d = \$ 3 800$
- (10)  $b - 020c - 006d = 2 100$
- (11)  $- 016b + c - 003d = 2 200$
- (12)  $- 003a - 032b - 033c + d = 12 000$

By combining equations and eliminating unknowns, the following results are obtained

$$\begin{array}{ll} a = \$4 239 44 & c = \$ 2 271 97 \\ b = 2 218 39 & d = 12 158 09 \end{array}$$

(See Section 25 for method of solving simultaneous equations)

These values are identical to those obtained by the other methods. However, solution by simultaneous equations is not as practicable as other methods. This is especially true where there are more than three reciprocal transfers of interdepartmental service expenses.

**Closing Service Department Accounts**—The completed work sheet showing accumulations and distributions is shown in Fig 13. The solutions presented show the totals of service department expenses including interdepartmental allocations (Fig 13, cols 6 to 12 inc). These amounts represent the total debits to accounts and are used in turn to make distributions to other service and to producing departments. Distributions represent credits and thus close the accounts.

**FINAL STEP AFTER DISTRIBUTION OF MANUFACTURING EXPENSES**—After all service department expenses have been distributed under whatever plan may be used, the total service expenses are lodged in the producing department accounts. The producing department expense totals now represent the direct producing department expense and indirect service expenses distributed to producing departments. These totals may be reduced to expense rates to be used in charging production (see Section 19).

## SECTION 19

### OVERHEAD AND PRODUCT COST

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## SECTION 19

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### OVERHEAD AND PRODUCT COST

#### Applied Expense Classifications

##### CHARACTERISTICS OF MANUFACTURING EXPENSE —

Direct material and direct labor costs either in total or per unit of product are obtainable through such devices as stores requisitions, bills of material scrap reports, time reports, etc. Overhead, however, cannot usually be related specifically to any particular item of output. Hence methods must be devised to spread overhead expenses over the production. Selection of the correct method of burden application, also called overhead costing or burden absorption, is vital, otherwise pricing policies, bids and estimates, and sales controls in general are affected adversely, inventories are incorrectly stated, and the net profit reported for the period is inaccurate.

##### ACTUAL VS PREDETERMINED OVERHEAD RATES —

Overhead may be applied to the product on the basis of rates established either after or before the expenditures are actually ascertained. If an overhead rate based on actual costs is to be used, the following formula results:

$O_a$  = Actual overhead for period

$P_a$  = Actual production for period in units, hours, or dollars

$\frac{O_a}{P_a}$  = Actual rate to apply to product

If a predetermined rate is to be used the following formula obtains:

$O_e$  = Estimated overhead for period

$P_e$  = Estimated production in units, hours, or dollars

$\frac{O_e}{P_e}$  = Predetermined rate

When actual overhead is used, the costing procedure cannot be completed until the close of the period. Often, this delay is disadvantageous, since final costs on completed work cannot be determined for some time after the order is finished, and, in general, the work of accounting department is delayed. Also, the value of results obtained is frequently open to serious question, and may be of doubtful worth in guiding future policies. However, under this scheme all overhead is costed to the production of the period.

When overhead to be applied to production is properly estimated in advance, product costs may be determined immediately on completion,

also peaks and valleys of seasonal activity are leveled and it is possible to recognize properly in costing the overhead, varying rates of operation due to cyclical factors. On the other hand, at the close of period there is a difference between the actual amount of overhead expense and the amount of overhead absorbed or applied to the product. This difference is called under- or overabsorbed overhead.

Predetermination of overhead expenses may be based on

- 1 Estimated actual expenses for the period
- 2 Estimated normal expenses for the period

The application of actual overhead expense for each month to the production for that month generally results in highly fluctuating unit costs. An estimate of actual overhead for the year, determined in advance and applied on the basis of a uniform rate throughout the period smooths out the monthly cost picture. The resulting unit costs are in a sense average costs and for that reason are more nearly representative costs than the actual costs. Predetermined normal overhead costs show what the unit costs might be under controlled spending conditions in relation to capacity operation even though the plant does not operate at capacity.

In one survey, it was found that 18 of 224 companies covered were using actual burden rates, while the balance of 206 companies, were using predetermined rates (NACA Bulletin, vol 19). This preponderance of predetermined rates reflects the modern trend but does not necessarily condemn the use of actual rates. The latter may be satisfactory if the volume of production is maintained at a reasonably consistent level over a period, or where operations as in canning are carried on during a short period making it possible if desired, to apply all overhead to the product.

**SOURCES OF DATA FOR ESTABLISHING BURDEN RATES**—If actual burden rates are to be used, the necessary data are

- 1 Production measured in units, weight, volume, hours, dollars, etc.
- 2 Factory overhead, in total, by expense classifications and by departments.

Information regarding production is obtained from appropriate plant reports, as illustrated for a bakery in Fig 1. The amounts for the several indirect labor elements of factory overhead are obtained from payroll distribution sheets. Amounts for indirect material are obtained from reports of materials used. Indirect factory supplies may be cleared through stores or, if purchased for immediate use, may be entered directly on expense distribution sheets. Depreciation charges are collected from plant and equipment records. Taxes and insurance are prorated from amounts established on the general books. Outside service costs are vouchered, with proper expense classification designated. All items are grouped, according to the account classification established, in subsidiary expense ledgers. In most cases it is desirable to have factory overhead analyzed by departments. This may be done through departmental expense distribution sheets. These sheets should also provide spaces for entering the apportioned overhead, i.e., redistributed service department charges. Thus, the total cost of operating a producing department is obtained. It is this total cost which is applied to the



productive output of the department for the period involved, where actual overhead costs are used

If predetermined rates are to be used in applying overhead, it is necessary to estimate the production and the amount of overhead expenses in advance. In such cases appropriate budgets representing a combination of past experience and future expectation supply the requisite data.

### METHODS USED TO APPLY OVERHEAD TO PRODUCT

—A variety of methods may be used for the application of overhead. The more common ones all of which are defined and discussed later in this Section, are

- 1 Percentage of direct labor dollar
- 2 Rate per direct labor hour
- 3 Rate per machine hour
- 4 Rate per unit of product
- 5 Percentage of direct material cost
- 6 Percentage of prime cost
- 7 Percentages based on sales or market prices
- 8 Supplementary rates

Rates may be plant-wide, i.e., blanket rates, or by departments, or by cost centers, the latter comprising building units, functional operations, machine groups or even individual machines. Where standard rates are used in a standard cost system, the usual bases are standard direct labor dollars, standard direct labor hours, and standard machine hours.

Fig 2 shows graphically the classification of methods of overhead application and their relation to each other. The first column lists the fundamental types or bases upon which rates may be established. Each of these is further subdivided as shown in the second column of the diagram. The third column lists the specific methods of burden application. Of these the first seven may be used in conjunction with any of the subdivisions in column two. The last one, the machine hour rate, is used only in connection with cost centers or specific machines.

BASES FOR ESTABLISHING RATES	SUBDIVISIONS FOR RATE DETERMINATION	METHODS FOR APPLYING RATES TO PRODUCTS
I Actual Costs (post determined)	Blanket	1 Percentage of direct labor dollar 2 Rate per direct labor hour 3 Amount per unit of product
II Expected Actual Costs (pre estimated)	Departmental	4 Percentage of direct material cost 5 Percentage of prime cost 6 Percentages based on market values 7 Supplementary rates
III Normal Costs (pre-determined)	Cost Center	8 Rate per machine hour

FIG 2 Chart Showing Methods of Overhead Application

**Extent of Use**—A research study made by the National Association of Cost Accountants shows clearly the extent of use of the various methods and the relative popularity of each (N A C A Bulletin, vol 19)



In the tabulation below the methods are arranged in the order of their preference by industry, taking into account their combined use either as a primary or as a secondary base

SUMMARY OF EXTENT OF USE OF METHODS OF APPLYING OVERHEAD TO PRODUCT

Methods Used	Number of Companies		Total
	Using as Major or Only Base	Using as Secondary Base	
Actual direct labor cost	96	13	109
Actual direct labor hours	27	21	48
Actual machine hours	30	13	43
Weight basis	7	29	36
Standard machine hours	13	22	35
Standard direct labor hours	29	4	33
Unit of product	11	18	19
Material cost		11	11
Prime cost	5	5	10
Standard direct labor cost	5		5
Miscellaneous	1	2	3
	<u>224</u>		

## Overhead Formulas and Their Application

**DIRECT LABOR DOLLAR FORMULA**—Applying overhead as a percentage of direct labor dollar is one of the oldest methods. The percentage is determined by dividing overhead expense by the dollar amount of direct labor and the overhead is applied by multiplying this percentage by the direct labor cost of each job or line of product. The computation of the rate may be expressed in a formula

$$\frac{\text{Overhead expense}}{\text{Direct labor dollars}} \times 100 = \text{Percentage of direct labor cost}$$

The items of the equation may be for the factory as a whole, for each department in the plant or for each cost center. The numerator for overhead and the denominator for direct labor dollars may be expressed in terms of actual, estimated actual, or normal costs. By keeping the numerator and denominator on the same basis the resulting percentages represent, respectively, actual, estimated actual, or normal rates. Some feeling has been expressed that the various factors are interchangeable, i.e., that it is feasible and at times reasonable to use the numerator on one basis and the denominator on another, e.g., a percentage of actual overhead to normal or standard labor. Such a mixture of bases is ordinarily not advisable and should be avoided. Nevertheless, there is nothing inherently wrong with this idea. One manufacturer of heavy duty machines reports that his plant has developed standards for material and labor, but owing to the disturbed conditions created by the war the task of standardizing overhead has been postponed. In the meantime, the actual expense is charged to production on the basis of standard labor cost. This concern feels that while the situation is not ideal, it is better to apply the overhead on the basis of a stable figure,

such as standard labor cost, rather than on a fluctuating basis of actual labor cost. The method adopted may serve during the period of transition from an actual to a standard cost basis. Its adoption, however, in a given case must depend on the nature of the business, the relationship between costs and prices and the degree and nature of control to be exercised.

Assuming the past month's expense for overhead for a certain assembly department was \$2,580 while the direct labor cost for the same department amounted to \$2,000, the overhead rate for that department would be computed as follows:

$$\frac{\$2,580}{\$2,000} = 129\%$$

In other words, for each dollar of direct labor, there is to be added \$1.29 of overhead expense. Thus, if subassembly A-261 required \$400 direct labor during the month, the overhead costed against it is as follows:

#### SUBASSEMBLY A 261

Direct labor	\$400
Overhead rate	129%
Overhead cost	<u>\$516</u>

**Departmental Direct Labor Dollar Method**—Fig. 3 illustrates the method for calculating direct labor cost burden rates on a departmental basis. It is described by Bennett (N. A. C. A. Bulletin, vol. 19).

It was determined to apply factory burden on the basis of a percentage of direct labor and to apply commercial burden as a percentage of total factory cost. The next problem to arise was whether a single factory burden rate should be used or whether separate rates should be developed for the different operating departments. A study of the product revealed that a relatively small number of products passed through all major departments for example upholstered chairs proceeded along quite a different manufacturing route than did highly polished tables. Consequently it was found essential to analyze the factory burden by major departments and then to use these departments as centers of burden application. These burden application centers were as follows:

Mill Room	Upholstering
Machine and Cabinet	Painting
Finishing	

Thus five different rates were needed to apply factory burden to cost and these rates were applied as percentages of direct labor.

The next step was that of setting up the burden budget or to use a term which I frequently adopt the 'development of factory burden' (Fig. 3). It may be noted that the plating department was charged with expense but that the total was absorbed by the other departments. It was found on analysis that the department was so small and the output so low that no practical worth would accrue by using a separate plating department rate.

Fig. 4 shows the cost card used to accumulate costs by style numbers of furniture, using the departmental rates developed in Fig. 3. Note that these are estimated actual rates for the application of overhead. In practice a safety margin of about 10% was added.

Account Number	NAME	Basic of Distribution	Eds. allocated Total	Mill Room	Machine and Cabinet	Finishing	Upholstering	Plating	Packing	General Factory
K 1	Supervision	Direct labor								
K 2	Repairs to Buildings									
K 3	Repairs to Machinery and Equipment	To general factory								
K 4	Ward and Dry Mills									
K 5	Heat and Light									
K 6	Power									
K 7	Trucking and Shipping	To general factory								
K 8	General Factory Expense	To general factory								
	Insurance on Buildings									
	Insurance on Machinery and Equipment	Total payroll								
K 9	Insurance Compensation									
	Taxes on Buildings									
K 10	Taxes on Machinery and Equipment									
	Depreciation on Buildings									
	Depreciation on Machinery and Equipment									
K 11	Freight In	To general factory								
K 12	Indirect Labor	Actual								
K 13	Mill Supplied Used	Total payroll	\$38 235	\$1 730	\$27 045	\$11 386 80	\$3 049 00	\$072	\$2 100	\$37 219
	Total									
	Distribution of General Factory and Plating	Total payroll		1 478	20 843	11 027 70	3 107 29		1 440	
	Total Factory Burden		\$38 235	\$3 208	\$47 887	\$23 423 50	\$6 110 29		\$3 540	
	Direct Labor		\$94 757	\$4 004	\$51 181	\$27 710 00	\$7 852 00		\$4 001	
	Burden Rates		87 8%	80 2%	93 5%	80 9%	78 4%		88 4%	

FIG 3 Development of Burden Rates

COST CARD							Style No _____	
Description							Cost Per _____	
Order No								
Date								
Material	Quan	Price	Amount	Quan	Price	Amount		
L mber								
Finishing Material								
Upholstering Material								
Hardware								
Total Material								
Labor and Burden	Labor	%	Burden	Labor	%	Burden		
Mill Room	7 00	80 2	5 61					
Machine and Cabinet	25 00	93 5	23 38					
Finishing	30 00	80 9	24 27					
Upholstering	35 00	78 4	27 44					
Painting								
Packing	3 00	88 4	2 65					
Total Labor and Burden	100 00		83 35					
Summary Material								
Labor								
Burden								
Total Factory Costs								
Commercial Expense								
Rate								
Amount								
Total Cost								
Add in Deductions								
Total Cost and Sales Deductions								
Selling Price								
Profit								

FIG 4 Cost Card Showing Departmental Overhead Application

**Blanket Labor Cost Rate**—If a blanket rate were used in this furniture factory it would be determined as follows

$$\frac{\text{Estimated total overhead}}{\text{Estimated total direct labor cost}} = \frac{\$83,225}{\$94,757} = 87.8\%$$

A comparison of results obtained under the blanket and the departmental rates may be made by using the data for the furniture case. Fig. 4 shows an overhead cost of \$83.30, resulting from the use of departmental burden rates developed in Fig. 3. The use of a blanket rate produces an overhead cost of \$87.80 (i.e., \$100 × 87.8%). Hence where different lines of product are manufactured requiring different processing times in several departments, blanket rates might not yield accurate costs for overhead.

**Advantages and Disadvantages**—The direct labor dollar method is easy to use, economical and simple, since all requisite data are available without further record keeping, i.e., the total of direct labor cost is available from the payroll summary. The important objections to this method arise from the following facts:

- 1 It ignores the contribution of value to the product by factors of production other than direct labor, e.g., machinery. In some departments it is not labor but expensive machinery that represents the prime production factor.
- 2 It rests on a dollar expenditure basis which is not necessarily a proper measure of the contribution of value since many overhead expenses such as taxes, property insurance, depreciation, etc. are functions of time.
- 3 It charges operations performed by high rate operators with proportionately more overhead than those operations performed by low rate operators. This results in faulty distribution of overhead to product where two or more operators in a specific department perform the same operation on different jobs or classes of product but are paid varying rates per hour.

These objections can be overcome where labor rates are uniform in each department and where direct labor is the main productive element.

**DIRECT LABOR HOUR FORMULA**—Applying overhead as a rate per direct labor hour involves a determination of the relationship between the amount of overhead expense to be applied and number of direct labor hours. Overhead is costed to the job or process by multiplying this rate by the number of direct labor hours as shown by time reports. The computation of the rate may be expressed in a formula:

$$\frac{\text{Overhead expense}}{\text{Direct labor hours}} = \text{Rate per direct labor hour}$$

The items of the expression may be actual, estimated actual, or normal. Also the items of the equation may be for the factory as a whole, for each department in the plant, or for each cost center. For example, assuming that overhead expense for the past month in the assembly department was \$2,680, while the total number of direct labor hours amounted to 3,685, then the overhead rate per direct labor hour in the department is \$70 obtained by dividing \$2,680 by 3,685 hours. That is, for each hour of direct labor, there is to be added \$70 of overhead expense. If subassembly A-261 required 710 hours of departmental direct

## DISTRIBUTION OF INDIRECT MANUFACTURING

	Base of Distribution	Total	Stores	Machine Shop
Floor Space		\$3 000	3 990	300
Value of Machinery		\$10 000		\$800
Number of Workmen		243	2	1
Number of Connected H P		30		3
Number of Electric Lamps		100	4	2
Amount of Production				
INDIRECT EXPENSES				
Supervision	Number of workers	\$ 2 000 00	\$ 10 00	\$ 8 00
Foremanship	Actual	1 500 00		
Indirect Labor	Floor space	500 00	00 50	5 00
Depreciation Machinery	Value of machinery	300 00		15 00
Taxes Machinery	Value of machinery	300 00		15 00
Rent	Floor space	2 000 00	242 00	20 00
Insurance Machinery	Value of machinery	200 00		10 00
Liability Insurance	Number of workers	100 00	80	40
Repairs (Labor and Material)	Actual	250 00		25 00
Stationary and Printing	Arbitrary	400 00	50 00	5 00
Miscellaneous Factory Expenses	Arbitrary	175 00	20 00	5 00
Heat	Floor space	400 00	48 40	4 00
Power	Number of connected H P	300 00		80 00
Light	Number of bulbs	200 00	8 00	4 00
Actual Amount of Used Requisition			\$445 70	
Value of Machinery				\$145 40
Amount of Production				
Floor Space				
Amount of Production				
A Total Expense		\$8 225 00		
B Productive Labor Hours per Department				
C Expense Rate per Productive Hour (A - B)				

FIG 5 Development of Departmental

labor during the previous month, the overhead costed against this item is as follows

## ST ASSEMBLY A 261

Direct labor hours	710
Overhead rate per hour	\$ 70
Overhead cost	<u>\$497</u>

Fig 5 uses actual expenses in computing direct labor hour rates on a departmental basis for a concern manufacturing uniforms. The method is described by Schroedel (N A C A Bulletin, vol 18)

A general burden rate cannot be determined for all departments by dividing the departmental expenses over the units of output in the factory. The labor cost method may be used as an expense burden for the cutting room, trimming room and the button department. In each of these departments the employees work substantially with the same equipment.

## EXPENSE TO DEPARTMENTS

Bush <sup>1</sup> & Dept	Ship Dept	Inspection and Packing	Cutting Room	Trim- ming Dept	Coat Shop	Pants Shop	Bullion Dept	Cap Dept	Office
400 \$100 5 1 1	2 800 \$200 3 2 4	000 4 4	5 700 \$100 22 8 15 0 200 (suits)	1 540 4 5 0 200 (suits)	3 580 \$8 000 120 10 30 0 000	3 000 \$3 000 75 11 20 3 200	400 \$100 5 2 2 000	000 2 2	5 150
\$ 40 00 1 70 00 6 00 3 50 3 50 14 50 2 50 2 50 30 00 5 00 5 00 4 80	\$ 24 00 42 00 0 00 0 00 168 00 4 00 1 70 50 00 25 00 38 00	\$ 32 00 10 00 3 00 3 00 40 00 2 00 1 60 25 00 15 00 8 00	\$ 180 00 900 00 88 00 3 00 244 00 2 00 9 00 25 00 30 00 10 00 64 80	\$ 32 00 200 00 28 00 3 00 92 00 5 00 1 60 5 00 20 00 12 00 18 40	\$ 900 00 400 00 128 80 180 00 180 00 514 00 120 00 40 80 70 00 70 00 30 00 102 80	\$ 616 00 400 00 45 50 90 00 90 00 182 00 60 00 30 80 50 00 70 00 30 00 36 40	\$ 40 00 100 00 6 00 3 00 24 00 2 00 2 00 10 00 20 00 10 00 4 80	\$ 16 00 80 00 10 00 3 00 3 00 40 00 80 5 00 25 00 18 00 8 00	77 50 310 00 90 00 30 00 62 00 20 00 5 00 20 00 5 00 1 46 56 70 7 82 7 56 \$20 50 200 \$1 04
<u>\$24 56</u>	<u>\$190 72</u>	<u>11 72</u>	<u>118 31</u>	<u>31 20</u>	<u>168 00</u>	<u>58 61</u>	<u>7 82</u>		
	<u>\$181 32</u>	<u>32 87</u>	<u>15 13</u>	<u>40 40</u>	<u>30 28</u>	<u>7 56</u>			
			<u>\$1 277 12</u>	<u>\$338 70</u>	<u>\$3 560 94</u>	<u>\$2 143 21</u>	<u>\$260 64</u>	<u>\$208 80</u>	<u>\$520 50</u>
			1 000	400	4 000	3 000	200	200	
			\$1 38	\$1 35	\$ 89	\$ 71	\$1 80	\$1 04	

## Direct Labor Hour Rates

under similar conditions. The wages are fairly uniform in each department and all the work performed is done by hand.

In the coat and pants shop the production center method can be used in distributing the departmental expenses because there are two classes of work performed—machine work and bench work. The labor hour method should be used for both machine and benchwork production centers because in both cases time is a dominant factor, wages are not uniform (mostly piecework rates), and all the employees work under similar conditions.

Fig 6 shows the cost card used to accumulate costs by part or style of uniform using departmental rates developed in Fig 5. Actual rates are applied.

**Blanket Labor Hour Rate**—A blanket rate using same illustration (Fig 5) is determined as follows:

$$\frac{\text{Total factory overhead}}{\text{Total direct labor hours}} = \frac{\$8 625}{8 800} = \$98 \text{ per hour}$$

DATE _____ 19 ____		COST CARD					NO. _____	
DESCRIPTION _____		NAME OF PART _____						
PLANT DEPARTMENTS	HOURLY OVERHEAD RATE	PRODUCTION COST				DEPARTMENT TOTALS	GRAND TOTAL	
		MATERIAL	LABOR HRS	FACTORY EXP				
Cutting Room	\$1 38							
Trim Dept	1 35							
Coat Shop	0 89							
Pants Shop	0 71							
Bullion Dept	1 30							
Cap Dept	1 04							

FIG 6 Applying Departmental Rates to Job Order Costs

As explained earlier, the plant manufactures a variety of uniforms, caps, etc. Conditions of manufacture vary from one department to another, and a blanket rate therefore does not provide the flexibility offered by departmental rates.

**Comparison of Direct Labor Dollar and Direct Labor Hour Methods**—A comparison of these two methods is made by Grover (NACA Bulletin vol 12) who says:

Assume that you have two mills, exact duplicates. On one of these mills you perform an operation that requires more skill and experience than the operation on the other mill. Naturally you pay more for the direct labor on the job. Does it cost any more to furnish a place to work for one man than the others? Does it cost any more to run one machine than the other? Does one man require more supervision? Probably the experienced workman, who is paid more per hour, requires less supervision, yet with the direct labor method of burden distribution we charge more burden to the jobs done by the higher priced workman and less burden to the lower priced workman.

Assume the labor cost on the operation performed on machine No 13 is \$100 and the labor cost of the operation on No 14 is \$150. The machines being duplicates and the operations having the same elapsed time, the burden is the same. The true costs of the jobs are:

On Mill No 13	Direct labor	\$100 00
	Burden	150 00
	Total	<u>\$250 00</u>
On Mill No 14	Direct labor	\$150 00
	Burden	150 00
	Total	<u>\$300 00</u>



If you distribute the \$300 burden cost to the jobs on the basis of direct labor the result would be

On Mill No 13	Direct labor	\$100 00
	Burden	120 00
	Total	<u>\$220 00</u>
On Mill No 14	Direct labor	\$150 00
	Burden	180 00
	Total	<u>\$330 00</u>

This condition is not overdrawn as it happens often in any plant whether labor is paid according to straight daywork or piecework.

**Advantages and Disadvantages of Labor Hour Rate**—The direct labor hour method is easy to use, and is an ideal base for application of overhead where labor operations constitute the central factor in production. The overhead of an organization is a dollar measure of the cost of maintaining efficient production at a bench or machine. The more important elements of this overhead, excluding indirect labor, are based on lapse of time as a common element (e.g. power, depreciation, supervision, insurance, rent, etc.) The direct labor hour method makes use of the time factor, and thus it answers a major objection of the direct labor dollar method since operations taking the same time are costed with the same overhead though the operators may be receiving different rates of pay.

A minor objection arises from the fact that additional information must be compiled and analyzed i.e., the number of direct labor hours by departments and products. However the data are already available on time reports. This method shares with the labor dollar method the disadvantage that it ignores the contribution of value to the product by factors other than direct labor. For example, it is inaccurate to cost overhead on a departmental direct labor hour basis for a machine shop composed of turret lathes, drill presses, and automatic screw machines.

**MACHINE HOUR RATE**—Applying overhead as a rate per machine hour requires finding the ratio between the amount of overhead expense to be applied and the number of machine hours. Overhead is then costed to job or process by multiplying this rate by the number of machine hours involved in a specific operation. The computation of the rate may be expressed as a formula

$$\frac{\text{Overhead expense for specific machine}}{\text{Machine hours}} = \text{Rate per machine hour}$$

Theoretically, the actual overhead and actual machine hours might be used. However this is ordinarily not done. Usually the computation is on the basis of the estimated actual expense or the normal expense for the coming period. Also the rate is computed for each machine, or group of machines where there are a number identical in cost and operation. Thus, the machine hour rate represents a predetermined estimate of the actual cost per hour, for overhead, of operating each machine. This rate, applied on a time basis to the jobs processed on the machine, should result in the absorption of actual overhead. Differences between actual and absorbed overhead are the result of error in estimating the amount of indirect expenses and number of hours of machine time.

# FACTORY OVERHEAD FOR THE

OVERHEAD ACCOUNT		Grand Total	PRODUCING DEPARTMENTS		
Code	Name		Dept 51 Forge Shop	Dept 52 Machine Shop	Dept 53 Assembly
7301	Fuel	\$ 9 000	\$ 9 000		
7302	Spoilage	1 200	480	\$ 400	\$ 320
7303	Heat	960	380	240	180
7304	Light	2 139	800	400	345
7305	Power	5 700	2 604	2 148	480
7306	Water	238			
7307	Compensation Insurance	1 581	634	320	382
7308	Auto Repairs	144			
7309	Auto Supplies	360			
7310	Indirect Factory Supplies	40 802	20 400	12 000	5 316
7311	Janitorial Supplies	180			
7313	Maintenance Materials Equipment	1 080	540	324	216
7314	Maintenance Materials Building	600	102	182	06
7316	Maintenance Labor Equipment	5 400	2 100	1 620	1 080
7316	Maintenance Labor Building	1 800	576	360	268
7317	Material Handlers	9 120			
7318	Toolroom Operators and Attendants	2 256			
7319	Other Indirect Labor	33 000	12 444	9 000	11 190
7320	Superintendent	4 300			
7321	Foremen	18 000	4 800	4 800	4 800
7322	Storekeeper and Attendants	7 200			
7323	Engineers and Draftsmen	11 400			
7324	Cost and Payroll Employees	5 640			
7326	Watchmen Janitors, and Elevator Operators	8 102			
7326	Truck Drivers	1 200			
7330	Medical Fees	1 900			
7331	Machine Royalty Rentals	55 200	28 800	14 400	12 000
7332	Patents Amortization	2 040	960	720	360
7340	Depreciation Building	2 232	720	480	380
7341	Depreciation Machinery	21 000	8 640	4 320	3 240
7342	Depreciation Office Equipment	360			
7343	Depreciation Automobiles	600			
7350	Insurance Buildings	1 116	800	240	180
7351	Insurance, Machinery	2 400	060	480	360
7352	Insurance, Office Equipment	36			
7353	Insurance Automobiles	240			
7354	Insurance Inventories	1 800			
7360	Taxes Building	1 674	540	360	270
7361	Taxes Machinery	4 200	1 680	840	680
		\$262 800	\$98 680	\$54 640	\$42 060

FIG 7 Departmental

## EXPENSE BUDGET

Year 19\_\_

SERVICE DEPARTMENTS				
Dept 65 Storeroom	Dept 66 Toolroom	Dept 67 Engineering	Dept 68 Cost and Pay roll	Dept 69 Supervision and General
\$ 84	\$ 36	\$ 48	\$ 12	
480	69	90	22	
930	88	120	120	
84	80	57	28	\$ 288
				46
				144
				880
720	432	1 146	504	84
				180
182	18	24	6	
366	54	72	18	
9 170				
	2 256			
				4 800
	3 600			
7 200		11 400		
			5 640	
				2 192
				1 200
				1 200
480	72	96	24	
1 080	2 160	1 798	432	
120			240	
240	36	48	12	600
120	240	192	48	
12			24	
				240
1 800				
360	54	72	18	
210	420	336	84	
\$22 848	\$9 585	\$15 481	\$7 283	\$12 334

Expense Budget

If it is estimated that a given turret lathe is to be operated 1 500 hours during coming year with an estimated overhead expense of \$3 300 machine hour rate is \$2 20 found by dividing \$3 300 by 1 500 hours That is for each hour of machining on the turret lathe there is to be added \$2 20 for overhead expense If part X 127 required 45 minutes for machining on this turret lathe the overhead costed against the part is as follows

## PART X 127

Machine time turret lathe	75 hours
Overhead per machine hour	\$2 20
Overhead cost	<u>\$1 65</u>

**Detailed Computation of Machine Hour Rates**—There are three steps in computing machine hour rates

- 1 Determination of the estimated overhead expenses for the period by departments This may take the form of a budget set up in form of an expense distribution sheet (Fig 7) The amounts given are the estimated actual expenses for the coming year If the budget were based on normal production normal rates would result
- 2 Regrouping of these expense items into three classes
  - a Specific charges to each machine such as power maintenance and depreciation
  - b Building costs such as heat and light
  - c All other general and service costs such as indirect supplies and labor not otherwise handled supervision, and engineering
 These classes of costs, with distribution to specific machines are given in Fig 8
- 3 Machine costs direct and prorated are combined to obtain total overhead expense to operate each machine during the year The machine rate is derived by dividing this total by the number of hours of operation This is shown in Fig 8

The estimated hours may take into account the time for set ups, or as in some cases separate rates may be set for set-up and for running time

Figs 7 and 8 are adapted from Van Sickle (Cost Accounting) The references in Fig 8 are to the following bases of distribution

- a Meters or horsepower rating of motors
- b Statistical record
- c Equipment ledger record
- d Machine valuation
- e Radiation surface
- f Floor space area
- g Direct labor hours worked in each cost center

The numbers in the columnar headings refer to individual machines

Overhead is costed to the product through the machine rates obtained in Fig 8 For example

## OVERHEAD COST, JOB 4313

Machine Number	Hours Required	Machine Rate	Overhead Cost
510	2	\$38 73	\$ 77 46
511	3	11 05	33 15
512	3	5 87	17 61
520	2	26 69	53 38
531	5	14 62	72 60
Total Overhead Job 4313			<u>\$254 20</u>

Code Number	ACCOUNT AND NAME	Total Overhead Expense	510	511	512	520	530	531
<b>DIRECT MACHINE CHARGES</b>								
7301	Fuel (a)							
7305	Power (a)							
7312	Maintenance Materials Equipment (b)							
7313	Maintenance Labor Equipment (b)							
7315	Machinists Royalty Rentals (b)							
7323	Patents Amortization (b)							
7341	Depreciation Machinery (c)							
7342	Insurance Machinery (d)							
7351	Taxes Machinery (d)							
	<b>Total Direct Machine Charges</b>							
		\$ 98 703	\$41 666	\$ 5 305	\$ 3 012	\$24 832	\$ 9 183	\$ 9 183
<b>BUILDING EXPENSE</b>								
7303	Heat (e)							
7304	Light (f)							
7314	Maintenance Materials Building (f)							
7316	Maintenance Labor Building (f)							
7340	Depreciation Building (f)							
7350	Insurance Building (f)							
7360	Taxes Building (f)							
	<b>Total Building Expense</b>							
		\$ 7 485	\$ 1 719	\$ 1 140	\$ 572	\$ 2 308	\$ 560	\$ 560
<b>GENERAL AND SERVICE EXPENSES</b>								
7307	Spoilage (g)	\$ 1 200						
7307	Compensating Insurance (g)	1 326						
7310	Indirect Factory Supplies (g)	37 716						
7319	Other Indirect Labor (g)	33 600						
7321	Foreman (g)	14 400						
7321	Store-room Expense (g)	22 848						
7365	Toolroom Expense (g)	9 535						
7366	Engineering Expense (g)	15 431						
7367	Cost and Payroll Expense (g)	7 233						
7368	Supervision and General Expense (g)	13 334						
	<b>Total General and Service Expenses</b>							
		\$155 633	\$43 577	\$21 789	\$ 9 368	\$34 239	\$23 343	\$23 343
	<b>Total Annual Machine Charges</b>							
		\$202 900	\$82 962	\$28 740	\$12 924	\$101 299	\$33 369	\$33 367
<b>Annual Machine Hours (Estimated)</b>								
			2 400	2 600	2 200	2 300	2 400	2 400
<b>Machine Hour Rate</b>								
			\$ 38 73	\$ 11 05	\$ 5 87	\$ 26 69	\$ 14 32	\$ 14 32

Fig 8 Computation of Machine Hour Rate

Use of estimated machine hour rates gives rise to under or over absorbed burden for the period involved because actual expenses and actual hours of operation differ from the estimates. The amount may be disposed of in various ways:

- 1 By recosting the jobs through the use of a supplementary rate
- 2 By closing the amount into profit and loss
- 3 By closing it into cost of sales
- 4 By prorating difference among cost of sales and the year end inventories of work in process and finished goods

**Comparison of Machine Hour with Direct Labor Hour Method —**  
The comparative results of these two methods, when one department contains two diverse pieces of equipment are shown by the illustration in Fig 9. The machine hour rates are obtained by dividing machine

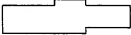

<b>PLANER</b>  476      \$14 198		<b>LATHE</b> 84 \$1568 	
BURDEN	TOTAL DEPARTMENTAL EXPENSE	PLANER	LATHE
BUILDING	\$33	\$28	\$ 5
EQUIPMENT	309	278	31
GENERAL	150	75	75
<b>TOTAL</b>	<b>\$492</b>	<b>\$381</b>	<b>\$111</b>
NORMAL HOURS	260	130	130
MACHINE HOUR RATE	—	2 93	0 85
MAN HOUR RATE	1 89	—	—

FIG 9 Comparison of Machine Hour and Man Hour Rates

operating costs by machine hours. The man hour rate is obtained by dividing total departmental expense (\$381 + \$111 = \$492) by man hours (260), which yields a man hour rate of \$1.89. As stated by Grover (N. A. C. A. Bulletin, vol 12)

Assume that it requires one man to run each of these machines and that the normal operating time for each is 130 hours per month. You will note the wide difference in area and machine values between the two machines. The man running the planer requires almost six times as much area in which to perform his operation as the man running the lathe; therefore the operation should be charged with almost six times the building expense. Although the planer may not depreciate any faster than the lathe yet measured in dollars to replace, the planer operations must bear about 9

times as much depreciation as the lathe also about 9 times as much taxes and insurance are paid for the planer

In such a case, accurate costs for overhead cannot be obtained by using a departmental direct labor hour rate. Machine hour rates are necessary. The same authority cited above states:

How could we expect to get costs of the individual parts made by using \$1.89 an hour burden charge on all operations when there is such a variation in cost of operating the different pieces of equipment in the plant as is here demonstrated with the planer and lathe?

<b>FIXED CHARGES</b>		
2 Taxes	\$ 15 248	
3 Depreciation	68 446	
4 Miscellaneous Charges	570	
Total Fixed Charges		\$ 84,264
<b>VARIABLE CHARGES</b>		
5 Indirect Labor	\$243 630	
6 Compensation Insurance	5 141	
7 Supplies	25 900	
8 Small Tools Purchased	16 000	
9 Perishable Tools Manufactured	11 450	
10 Repairs	14 250	
11 Purchased Power	12 000	
12 Miscellaneous Shop Expense	13 000	
13 General Administrative Expense	14 725	
14 General Selling Expense	20 150	
15 Flak Maintenance	150	
16 Experimental Expense	—	
17 Washroom Maintenance	70	
18 Shop Toilet	200	
19 Hospital Expense	70	
20 Apprentice Labor	400	
21 Finished Product Moving	2 200	
22 Motor Maintenance	275	
23 Shifting, and Hanger Maintenance	475	
24 Jig, and Fixture Maintenance	6 100	
25 Small Tool Maintenance	8 500	
26 Electrical Maintenance (not motors)	3 750	
27 General Labor	3 500	
28 Platform and Truck Maintenance	375	
29 Replacement of Parts on Machines Sold	2 500	
Total Variable Charges		411 211
Gross Annual Burden		\$495,475
<i>Deduct</i>		
Administrative Expense	\$ 76 426	
Selling Expense	72 634	
Development Expense (Capital)	6 000	
Unused Space and Equipment	6 418	
Other Charges (from Department 33)	1 000	
Maintenance—Department 25	4 182	
Tool Making—Department 26	10 519	
Petty Order—Department 27 (25%)	3 927	
Jig and Tool Design—Department 34	7 391	
Total Deductions		188 497
Net Manufacturing Burden		\$306 978

Fig 10 Estimated Annual Overhead

The machine tool industry makes extensive use of machine hour rates in applying overhead. The following illustration comes from a leader in the manufacture of its line of equipment. Fig 10 shows an estimate for the year of total manufacturing burden. This is analyzed by departments. Fig 11 presents an analysis for Department 17 bar machines. It was determined that from a cost viewpoint all bar machines in department 17 fell into four groups. Department 17 burden was then redistributed to these four groups (Fig 12). Group I contains 6 machines while group IV contains but one machine. Similarity in the cost of the machine floor area required and the operating speed, are factors which determine the grouping. The total charges for each group divided by the estimated hours of operation for each group yield a machine hour rate for the year. As a job works through the plant, machine times are reported to the cost department. These are accumulated in a job cost envelope. When the job is finished, a summary is made for all cost elements, including overhead. A summary for the overhead cost of making 6 spur gears is shown in Fig 13. All machine rates for machines in other departments were determined as illustrated for bar machines of Department 17. Fig 12. The overhead cost as obtained in Fig 13 is entered on the job cost card for the 6 spur gears along with the other elements of cost (Fig 14). The total cost divided by the number of good gears completed (6) yields the final unit cost of production.

## DEPARTMENT 17 BAR MACHINES

	Estimated Annual Charge	
<b>FIXED CHARGES</b>		
Building Expense—Department 37	\$ 901	
Equipment Charges	<u>3 895</u>	
Total Fixed Charges		\$ 4 796
<b>VARIABLE CHARGES</b>		
5 Indirect Labor	\$ 950	
6 Compensation Insurance	267	
7 Supplies	100	
8 Small Tools Purchased	300	
9 Perishable Tools Manufactured	750	
10 Repairs	900	
12 Miscellaneous Shop Expense	25	
22 Motor Maintenance	20	
23 Shafting and Hanger Maintenance	10	
24 Jig and Fixture Maintenance	80	
25 Small Tool Maintenance	400	
26 Electrical Maintenance	<u>100</u>	
Total Variable Charges		\$ 3 902
<b>REDISTRIBUTED SERVICE DEPARTMENT CHARGES</b>		
Tool Crib—Department 23	\$1,561	
General Manufacturing Burden—Department 31	7,085	
Power and Light—Department 39A	<u>1 094</u>	
Total Redistributed Charges		9,740
Total Annual Burden		<u>\$18 438</u>

FIG 11 Expenses Applicable to Bar Machines



	Basis of Distribution	Group I	Group II	Group III	Group IV	Total
BASIC DATA	Floor Space (square feet)	908	1 108	1 734	510	4 260
	Machines (cost)	\$7 668	\$16 687	\$15 517	\$8 510	\$48 382
	Jigs and Fixtures (cost—or prorated on value of machines)	289	586	545	800	1 700
	Equipment	\$7 950	\$17 273	\$16 062	\$8 816	\$50 080
OVERHEAD	Building Expense at \$.211502 per square foot	\$ 192	\$ 234	\$ 367	\$ 108	\$ 901
	Equipment Charges	617	1 344	1 349	689	3 899
	Power	173	313	363	245	1 094
	Tools Repairs and Tool Crib	657	1 430	1 330	729	4 146*
	Other Charges	2 968	2 989	2 009	467	8 433†
	Total	\$4 607	\$ 6 239	\$ 8 318	\$9 234	\$18 498
ESTIMATED ANNUAL HOURS		9 750	9 700	6 600	1 500	27 600
RATE PER HOUR		\$ .47	\$ .65	\$ .81	\$1 .45	

\* Made up of tool crib charges plus all variable items except 5 6 7 (Fig 11)

† Made up of general manufacturing burden plus items 5 6 7 (Fig 11)

FIG 12 Determination of Machine Rates

## Job No 329

	Operation	Dept	Mach	Time	Machine Rate	Overhead Cost
1	Turn drill face bore, chamfer ream	17	261 A	8 4	\$ 81	\$ 6 80
2	Skim diameter of hub skim both ends	16	81	2 4	1 15	2 76
3	Hob teeth	14	16 H	7 3	1 90	1 87
4	Chamfer teeth	14	36 B	1 8	1 50	2 70
5	Broach keyway	14	196	1 4	1 10	1 54
6	Burr	3		2 5	75	1 88
7	Grind hole	11	7 A	5 5	2 00	11 00
8	Surface grind	10	133	8	2 15	1 79
	Total Overhead Cost					<u>\$42 27</u>

Fig 13 Summary of Overhead Expense

**Advantages and Disadvantages of Machine Hour Rates**—Where machinery is the main factor in production, the machine hour method constitutes the best way to apply overhead. The basic reasons for this have been stated by Van Sickle (Cost Accounting)

- 1 From the cost accounting point of view it affords the most accurate method of allocating overhead expenses to each job
- 2 From the engineering point of view, it provides an ideal method for estimating the cost of a job on a specification and route sheet with a high degree of accuracy
- 3 From the marketing point of view, it makes it possible for the sales engineer to quote more accurate estimated selling prices for jobs
- 4 From the management point of view it involves the use of an overhead costing method which is scientific logical, and theoretically sound, in addition to being practical in its use. The management therefore can depend upon cost reports to show accurate costs and it can feel certain that the price quotations to customers are not grossly understated or overstated, thus avoiding either operating losses or the failure to obtain jobs. From the management point of view it also provides a basis for the measurement of the monthly cost of idle machines

Note that this method uses time as a base in applying overhead expense. It possesses special advantage over other methods where one operator tends several machines (e.g., in weaving), or where several operators are required for each machine (e.g., in cigar making). Finally, by adding the rate paid the operator to overhead rate for machine a cost center rate is easily and simply obtained.

The important objections to the machine hour method are as follows

- 1 Additional information, not otherwise needed must be provided in detail i.e., machine times for each operation. This increases the cost of the accounting procedure and hence some concerns do not find it practicable to use a machine hour rate
- 2 By its very nature this method precludes use of a blanket rate. Individual or group machine rates must be used, thus increasing the detailed cost work
- 3 The machine hour method is not universally applicable it can be used only for costing those operations performed by machinery

DATE FINISHED											
QUANTITY GOOD 6											
				TOTAL COST				COST EACH			
PRODUCTION LABOR											
BURDEN				\$	42	27		\$	7	04	50
MATERIAL						35	36			58	93
MATERIAL BURDEN 15%						5	30			8	83
DRAWING LABOR											
PATTERN LABOR											
W ACCOUNT %											
STOCK 1%											
TOTAL											
HOURS											

FIG 14 Job Cost Envelope, Showing Application of Overhead

Many concerns find it possible to use direct labor rates uniformly throughout the plant, relatively few find it possible to use only machine hour rates, other types of rates must be used in combination with them

**UNIT OF PRODUCT METHOD**—Application of overhead on the basis of the number of units of product manufactured during the period is the simplest and most direct method for costing overhead. The overhead rate is obtained by dividing the amount of overhead by the units of product. Expressed as a formula, it is

$$\frac{\text{Overhead expense}}{\text{Number of units of product}} = \text{Overhead cost per unit}$$

As in previous cases the terms of expression may be actual, estimated actual, or normal also they may be for the factory as a whole, by departments, or by cost centers. For example if actual overhead expense for an assembly department amounts to \$2 580, while the number of assemblies completed totaled 500 then the overhead cost per unit is \$5 16 (that is \$2,580 divided by 500)

The shoe industry affords an example of the application of overhead by the unit of product method (burden per pair of shoes), in this case including commercial burden. It should be noted however, that no commercial burden is permitted to find its way into inventory values. On this point, Bennett (N A C A Bulletin vol 16) says

In the case under review costs and expenditures for cost figuring purposes were segregated into the following four major divisions

- 1 Material Cost
- 2 Direct Labor Cost
- 3 Burden Cost
- 4 Deductions from Selling Price

Burden therefore, will include every other cost of the business that is not included in material, labor, or sales deductions as defined herein. In the case under consideration burden was applied as a single flat rate per pair of shoes and included both factory and commercial overhead. It is not argued that either of these bases is correct in all factories. It is however my opinion that a single burden rate applied to costs on a flat rate per pair basis represents the most practical and feasible plan for the great bulk of plants in this industry.

Fig 15 gives estimated burden for plant in question. It is set up in such a way that output for year absorbs total expenses for same period, including commercial items, as listed. Burden per pair is obtained by simple division. In this case it was modified upwards to \$2 93 per pair. Fig 16 shows the application of the rate to product lines. The illustration is taken from Bennett (N A C A Bulletin, vol 16). The burden cost of \$2 93 per pair is applied uniformly to all seven lines of product. This is probably not an ideal solution because women's shoes vary widely in size, material, style, price, etc, and a flat cost per pair therefore does not seem to represent a common denominator. Bennett himself recognizes the force of this point, but defends his position by stating

I admit it is not wholly accurate but neither is any other practical plan of burden application that can be advanced. Experience has indicated that in the average medium size women's shoe factory, a single burden rate to include both factory and commercial burden and applied as a flat per pair rate, will prove extremely satisfactory from the standpoint of simplicity, and it will also be relatively accurate. Furthermore it possesses the great advantage of lending itself readily to the plan of simple accounting control that is so essential in this industry. If the output is such that a wide price range of shoes is made then the flat per pair burden plan will have to be abandoned in favor of the percentage of direct labor method. But in the usual factory the point to watch is that the material and labor costs are being accurately figured and that the burden rate is such that the output for the year will absorb the total expenses.

## BURDEN BUDGET

FOR YEAR ENDING

		Total Yearly Budget
Basis—Estimated Output 800 pairs per day and 50 weeks of 8 days or 270 days = 200 000 pairs per year Total yearly sales at \$2 00 = \$400 000 00		
L 1	Supervision	\$
L 2	Nonproductive Labor	
L 3	Light Heat Power and Water	
L 4	Rent	
L 5	Freight and Express In	
L 6	Repairs	
L 7	Supplies and Expense	
L 8	Rentals and Royalties	
L 9	Cripples	
L 10	Findings	
L 11	Sundry Materials	
L 12	Insurance	
L 13	Taxes	
L 14	Depreciation	
Total Factory Burden		<u>\$37 070 00</u>
M 1	Executive Salaries	\$
M 2	Office Salaries	
M 3	Telephone Telegraph and Postage	
M 4	Office Stationery Supplies and Expense	
M 5	Legal and Accounting	
M 6	Salesmen's Salaries	
M 7	Traveling Expense	
M 8	New York Office Expense	
M 9	Freight and Express Out	
M 10	Advertising	
M 11	Credits and Collections	
M 12	Bad Debts	
M 13	Samples	
M 14	General Administrative and Selling Expense	
Total Commercial Burden		<u>\$19 766 00</u>
Total Burden		<u>\$57 436 00</u>
Number of Pairs of Shoes		200 000
Burden per Pair		\$ 287
Burden Rate to Use		\$ 293

FIG 15 Determination of Overhead Cost per Unit of Product

**Advantages and Disadvantages of Unit Overhead Method**—The unit of product method for applying overhead is the simplest and most direct. However, its usefulness is limited to those situations where but one product, or a few closely related products possessing a common denominator, such as weight, are manufactured. Where no natural common denominator exists one may be devised by resorting to a point basis or some other weighting factor. If this fails, the method breaks down.

**UNIT OVERHEAD COSTS ON POINT BASIS**—The method of stating the quantity of production for a period must be adapted to the character of industry. For example, units may be expressed as

All Prices Are Per Pair	# 3111 Plain Regent Pump	# 3010 Fancy Pump	# 304 Suede Ox- ford Pat Trim and Heel	# 3010 Reptile Tip and Fox Pump	# 304 Reptile Saddle and Fox Oxford	# 6021 Reptile Vamp and Eye Face	# 6021 All-Over Alligator Oxford
Selling Price	\$1 60	\$1 70	\$1 80	\$ 00	\$2 25	\$2 50	\$2 75
Deductions from Selling Price							
Discount 7%	112						
Commission 3%	048						
Loss on Allowances 1%	016						
Total Deductions	176	187	198	22	\$470	\$75	2025
Net Selling Price	\$1 424	\$1 513	\$1 602	\$1 78	\$2 0025	\$2 225	\$2 4475
Cost							
Material Cost	\$ 623						
Fittings Cement, and Cases	100						
Laces							
Total Material Cost	742						
Direct Labor Cost	393	293	99	293	283	283	393
Burden Cost—20 cases per Day	293						
Total Cost	1 428	1 534	1 594	1 784	2 010	2 062	2 492
Net Loss	004						
Net Profit							
5% Profit	08						
Additional Profit Needed	\$ 084	\$ 108	\$ 082	\$ 104	\$ 1700	\$ 043*	\$ 1870
Selling Price Should Be	\$1 684	\$1 806	\$1 882	\$2 104	\$2 37	\$2 432	\$2 632

\* Indicates a red figure

FIG 16 Uniform Application of Unit of Product Burden Rates

pounds, tons, 100's or 1,000's, gallons, feet, barrels, or per each unit. Weight as a basis is especially useful where processing is uniform but the product is packaged in several sizes, differentiated by weight in each container. This situation prevails in drugs and cosmetics. Where weight or volume does not provide a common denominator, there is the possibility of using a point base, derived by assigning a statistical point value to each product made as discussed below.

Application of overhead costs on the basis of unit of output may be illustrated by reference to the manufacture of mattresses. In this case there is a standard product with no important grade differences. Unit costs for overhead in total and by departments are obtained in each case by dividing the cost by the number produced. These operation or department costs are then allocated to the different styles of product on a point basis. The data below are taken from Blocker (Cost Accounting).

It may be assumed that in the first process, the sewing room, an analysis of material labor and factory expense conditions results in the assignment of the following weighted averages:

Style X	5 points
Style Y	10 points
Style Z	15 points

Thus in the first process material costs of ticking costs of cutting and costs of sewing are estimated to warrant giving style Z an importance three times as great as that of style X. The following schedule shows the weighted average production of 1,000 mattresses for a month:

Style	Production	Weighted Average per Unit	Total Points
X	200	5	1 000
Y	500	10	5 000
Z	300	15	4 500
Total	1,000		10 500

The figure representing the total costs of the sewing room, \$1 573, is divided by 10 500 points resulting in a cost of \$0 14981 per point. Unit costs and total costs of production for the sewing room assigned to each style of mattress are as follows:

Style	Points	Cost per Point	Cost per Mattress	Produc- tion	Total Cost
X	5	\$ 14981	\$ 74905	200	\$ 149 81
Y	10	14981	1 4981	500	749 05
Z	15	14981	2 24715	300	874 14
Total				1,000	\$1,573 00

The above costs per point include material and labor, as well as overhead. The unit cost per mattress for overhead may be obtained quite readily by dividing the total production in terms of points (10,500) into the overhead cost of the sewing room for the period (\$318), and using the resulting rate to charge the production.

\$318 — 10 500 points = \$ 03029 per point for overhead

Style	Points	Overhead Cost per Point	Overhead Cost per Mattress
X	5	\$ 03029	\$ 15145
Y	10	03029	3029
Z	15	03029	45435

**UNIT OVERHEAD COSTS ON WEIGHT BASIS**—Use of weight as a common denominator in applying overhead expense is shown in the table below, taken from Van Sickle (Cost Accounting)

**OVERHEAD APPORTIONMENT ON WEIGHT BASIS**

Products Manufactured	Total	P	Q	R
1 Number of units produced		12 000	8 000	4 000
2 Unit weight of product		2 lbs	1 5 lbs	1 lb
3 Total weight produced	40 000 lbs	24 000 lbs	12 000 lbs	4 000 lbs
4 Cost per pound	\$ 55625	\$ 55625	\$ 55625	\$ 55625
5 Overhead cost applied	\$22 250	\$12 350	\$8 675	\$2 225
6 Cost per unit		\$ 1 1125	\$ 834375	\$ 55625

**MATERIAL COST METHOD**—Overhead may be distributed to product on the basis of the cost of direct material consumed in producing the product. The formula for computing such a rate is

$$\frac{\text{Overhead expense}}{\text{Direct material cost}} = \text{Percentage of overhead per direct material dollar}$$

The expression may be in terms of actual, estimated actual, or normal. It could be used on a departmental, or on a blanket basis. It does not, however, have wide usefulness but does find application in special situations. The National Battery Manufacturers' Association recommended using direct material cost as a basis for applying overhead in one of their early manuals. However, the present manual (1934) has dropped the suggestion.

Some use is found for the material cost method as a means of distributing a portion of overhead expense known as material burden comprising the costs of purchasing, receiving, testing, storing, and handling raw materials. Used in this manner it constitutes a secondary rate the principal portion of overhead being distributed by one of the other methods. Thus one machine tool manufacturer uses a percentage of material cost to apply a portion of overhead to completed jobs. The computation of rates used is shown in Fig 17. Raw materials handled are separated into two main classifications, separate percentages being computed for each class. It was not anticipated that percentages would be identical. After the material cost is determined from costed stores slips and entered on a job cost card, the material burden is added by the application of the proper percentage. This is illustrated in Fig 17.

**Material Burden Applied on Weight Basis**—In certain cases material burden may be applied more equitably by using weight instead of cost. This is the case of one manufacturer of springs, as indicated by Seeber (N A C A Year Book, 1937).

Material burden is applied to cost on a per pound basis because it would cost no more to purchase store record, and deliver to production a



## RECEIVING AND RAW STORES DEPARTMENT 20

Item	Basis of Distribution	C-stings	Steel and Sundry	Total
<b>FIXED CHARGES</b>				
Building Expense	Floor area	\$ 1 019	\$ 589	\$ 1 618
Land	Floor area	5	3	8
Equipment Charges	Value of equipment	1 700	254	1 954
Inventory Charges		70	43	113
Total Fixed Charges		2 794	889	3 683
<b>VARIABLE ELEMENTS</b>				
Indirect Labor	Number of men	7 000	2 000	9 000
Compensation Insurance	Payroll	44	20	64
Supplies	Estimate	10	10	20
Small Tools Purchased	Estimate	150	150	300
Perishable Tools Manufacturing	Estimate	35	40	75
Repairs	Estimate	130	135	265
Miscellaneous Shop Expense	Estimate	150	150	300
Total Variable Charges		7 519	2 505	10 024
<b>REDISTRIBUTED SERVICE DEPARTMENTS</b>				
Crane Service	Estimate	600	51	651
Compressed Air	Estimate	243		243
Tool Crib	Estimate	78	78	156
Pattern Shop	Estimate	13 772		13 772
General Manufacturing Burden	Number of men	700	296	996
Trucking	Estimate	1 000	368	1 368
Power and Light	Estimate	67	100	167
Total Redistribution Charges		16 460	893	17 353
Total Annual Burden		\$ 26 773	\$ 4 297	\$31 070
Estimated Value Handled		205 000	33 000	
Percentage		13.06%	13.0%	
Rate to be used		15%	15%	

FIG 17 Computation of Material Overhead Rates

pound of material valued at one dollar than it would a pound of material valued at 6 cents. With us this is an actual condition as the average cost of material used will approximate about 9 or 10 cents per pound but flat stock will vary from 5 to 40 cents per pound and wire will cost as low as 3 cents per pound to as high as \$5.

We are using a material burden rate of one half cent per pound which added to the higher priced material is not very noticeable but when added to rolling wire which costs in the neighborhood of 3 cents per pound, becomes important.

A manufacturing concern using only one grade of steel such as all silver or all brass will find it optional to distribute material burden on either the per pound basis or total material cost providing they use standard costs which will not fluctuate with constantly changing conditions. But unless the amount of labor and burden used in processing this material is approximately the same on each piece or pound it does not seem reasonable to absorb this cost through operating burden.

**Error Caused by Other Methods of Application**—Listed below are several cost summaries which are taken from our actual records and which show definitely why we find it necessary to carry a separate account for material burden.

CUSTOMER No 1			
Job No 1		Job No 2	
8 611 pounds at cost	\$1 388 62	16 631 pounds at cost	\$1 084 91
Material burden	43 05	Material burden	83 15
Total material and burden	\$1 431 67	Total material and burden	\$1 168 06
Operating labor and burden	1 449 39	Operating labor and burden	485 44

Let us assume that these two orders combined would absorb the same amount of material burden regardless of the method used in distribution. If we apply this burden on the cost of material instead of the per pound basis they would be charged with \$70 85 and \$55 35, respectively. If material burden were added on the basis of operating labor and burden, their share would be \$94 54 and \$31 66.

CUSTOMER No 2			
Job No 1		Job No 2	
35 479 pounds at cost	\$ 7 985 00	78 833 pounds at cost	\$ 5 289 75
Material burden	177 40	Material burden	304 17
Total material and burden	\$ 8,162 40	Total material and burden	\$ 5 683 92
Operating labor and burden	10 581 16	Operating labor and burden	3 484 03

Material burden applied to these orders on the basis of the cost of material would charge job No 1 with \$343 81 and job No 2 with \$227 76, whereas if it were distributed on operating labor and burden then portion would be \$429 99 and \$141 58 respectively.

Now let us take two different customers each with an entirely different spring and we have the following condition.

Customer No 1		Customer No 2	
9 220 pounds at cost	\$ 677 17	9 690 pounds at cost	\$ 3 817 70
Material burden	46 10	Material burden	48 45
Total material and burden	\$ 723 27	Total material and burden	\$ 3 866 15
Operating labor and burden	274 20	Operating labor and burden	11,120 02

Material burden spread on material cost brings to customer No 1 a charge of \$14 24 and to customer No 2 a charge of \$80 31. Apportioned to

these customers through operating labor and burden customer No 1 would absorb \$2.28 and customer No 2 \$92.27

To those who doubt the necessity for a separate material burden account on the theory that it would not affect the price per thousand springs to any great extent let me further state that some springs weigh as little as a few ounces per thousand while others will weigh as much as 50 pounds each

There is also material burden which is applied to outside steel shipments. In total our main plant material burden amounted to over \$90,000 for the year. We would not want to add this cost to general factory expense and distribute it on some arbitrary basis as we only charge to general factory expense those costs which we definitely cannot allocate in any other manner.

A further application of the method is found in the full-fashioned hosiery industry. Since both cotton and silk are handled in the material handling department, the joint departmental cost is apportioned on the basis of a careful estimate of the relative amounts of labor and expense incurred on each product. According to McCullaugh (Full Fashioned Hosiery Industry) silk requires 50% more care and attention than cotton. Actual production figures are therefore converted into equated figures by multiplying silk production by 1.50 and cotton by 1.0. This is of course similar to the point system explained earlier in this Section (pages 1039-1042). The computation of the material burden rate, adapted from McCullaugh, appears as follows:

#### MATERIAL HANDLING DEPARTMENT

Direct Charges	
Labor	\$
Yarn Testing	
Freight and Express	
Miscellaneous Supplies	
Miscellaneous Charge	
Repairs to Machinery and Equipment	
Repairs to Building	
Total Direct Expenses	<u>\$ 397.16</u>
Share of	
Fixed Charges	\$
Boiler	
Power	
Trucking	
General Factory	
Total Apportioned Charges	<u>\$ 247.08</u>
Total Department Expense	<u>\$ 644.23</u>
Production	
Silk (9,137 lbs × 1.5)	13,706 lbs
Cotton (4,281 lbs × 1.0)	4,281 lbs
Total Equated Production	<u>17,987 lbs</u>
Overhead per equated pound	<u>\$ 0.35872</u>

Overhead is then charged to each material at the unit rate on the equated weight basis:

Silk (13,706 × 0.358164)	= \$490.90
Cotton (4,281 × 0.358164)	= 153.33
Total distributed	<u>\$644.23</u>

**Advantages and Disadvantages of Material Overhead Rates**—The direct material cost method is easy and simple to use. It gives reasonably accurate results where grades and prices of raw materials do not differ widely, where quantity and cost of material in each product is uniform, and where processing is uniform. It has usefulness in special departments of some large organizations, in very simple types of small business, and in the application of material burden. The disadvantages are

- 1 There is no logical relationship between manufacturing expense and the cost of raw material used
- 2 As in the direct labor cost method the time factor is entirely lacking
- 3 Where prices of items of raw material differ widely the products made from the items of high price are weighted with more than their share of overhead
- 4 This method is inequitable where part of the material passes through all processes, and part through only some processes

**PRIME COST METHOD**—Overhead may be applied to the product by using prime cost (direct labor and direct material) as a base. The mechanics are similar to those of the direct labor cost and material cost methods. The computation is as follows:

$$\frac{\text{Overhead expenses}}{\text{Direct material} + \text{direct labor dollars}} = \text{Percentage of prime cost}$$

As in other methods the factors of the expression may be in terms of actual, estimated actual, or normal, also, they may be blanket or departmental in nature. Thus if overhead expense for a certain mixing department totals \$3 600, while direct material cost is \$2 300 and direct labor cost is \$1 700 the rate for the application of overhead is

$$\frac{\$3\,600}{\$2\,300 + \$1\,700} = 90\%$$

That is for every dollar of prime cost add \$90 for overhead. The overhead cost applicable to each process for the month is determined by applying this rate:

#### PROCESS A 11

Mixing Department	
Direct material cost	\$1 030
Direct labor cost	770
Prime cost	<u>\$1 800</u>
Overhead cost at 90%	1 620
Total cost	<u><u>\$3 420</u></u>

**Advantages and Disadvantages of Prime Cost Method**—The prime cost method is simple and easy to use, since all data are immediately available without additional compilation. Its use is restricted, however, to those cases where there are no wide variations in processing. It is likely to prove more useful for certain departments, rather than for the plant as a whole. The objections to the method are

- 1 There is no logical relationship between major portion of overhead cost and dollar value of raw materials used
- 2 It does not make use of the time factor in applying overhead

- 3 It is unlikely that accurate overhead costing results from using both direct material and direct labor dollars, instead the results are further confused by combining the errors of the material cost and the direct labor dollar methods

**SUPPLEMENTARY RATES**—Supplementary rates are used to adjust the amount of overhead costed into production on a predetermined basis to the actual amount for the period. As the name implies, they are used in connection with other rates. If these predetermined rates were based on estimates of actual overhead for the coming period, a supplementary rate may be used at the close of period to adjust to actual cost and thus absorb over- or underapplied expense. If the predetermined rates were based on normal costs and production, a supplementary rate may be used at the close of the period to afford a comparison by job or product line, between overhead cost on a normal basis and on an actual basis.

Where predetermined rates are used, a difference always exists between the actual amount of overhead expense for the period and the amount of absorbed overhead expense. This under- or overabsorbed overhead divided by the number of hours, dollars or units gives a supplementary rate thus:

$$\frac{\text{Actual overhead} - \text{Absorbed overhead}}{\text{Hours, dollars or units}} = \text{Supplementary rate}$$

Assuming a machine rate per hour for a turret lathe of \$2.20 actual hours of operation for the month of 1,450, actual overhead expense on the turret lathe of \$3,560 and machine time for part X 127 of \$75 per hour under this situation the amount of overhead costed to jobs during the month amounts to:

$$1,450 \text{ hours} \times \$2.20 \text{ per hour} = \$3,190 \text{ of absorbed overhead}$$

Since the actual overhead charged against this turret lathe totals \$3,560 there is underabsorbed overhead for the period of \$370. A supplementary rate is then computed and used to create additional charges to the product to absorb the actual costs. This rate computed at the end of the month is \$255 per machine hour obtained by dividing \$370 by 1,450 hours. That is, for each machine hour there is to be added \$255 additional to adjust the overhead applied to actual.

The overhead cost of part X 127 now becomes:

Overhead cost on machine hour basis (75 × \$2.20)	\$1.65
Supplementary cost for overhead to adjust to actual (\$255 per hour × 75)	19
Overhead cost actual	<u>\$1.84</u>

If the overhead absorbed during the month by the use of the estimated rates is in excess of actual overhead, the adjustment is in the form of a deduction from the previously applied overhead. An alternative method for computing the supplementary rate expresses the underapplied overhead as a percentage of the overhead already applied. Using the same illustration as above, the results are as follows:

1 Underapplied expense (\$3,560 - \$3,190)	\$ 370
2 Applied expense	\$3,190
3 Supplementary rate (line 1 - line 2)	11.6%

## ADJUSTED COST OF PART X 127

Applied expense	\$1 65
Add supplementary cost (11 6% of \$1 65)	19
Actual overhead cost	<u>81 84</u>

Supplementary rates are not limited to those cases where machine hour rates have been used, they may be computed in connection with any method

**Advantages and Disadvantages of Supplementary Rates**—There is no need for supplementary rates where actual overhead has been applied to production, since there can be no under- or overabsorbed overhead in such cases. Where estimated actual or normal rates have been used, supplementary rates can be calculated and applied. Their principal advantage lies in the fact that they make possible the costing of total actual overhead to the product produced. If estimated actual rates have been used, and they prove to be greatly in error, it is necessary to adjust the cost sheets to obtain relatively accurate information. This is the case on government contracts run on a cost-plus basis (cost being defined as actual cost for the period of the specific contract). Supplementary rates, properly computed, offer one means of achieving actual cost in so far as the overhead element is concerned. Where normal rates are in effect, the use of supplementary rates gives additional cost information for purposes of comparison. In short, this method permits the use of cost controls available under predetermined or standard rates while furnishing actual costs when and if needed.

On the other hand final disposition of the cost sheets is delayed until after the close of each month, also the use of supplementary rates greatly increases the detailed cost work since job cost cards must be recomputed. In a seasonal business where estimated rates have been determined for a year in advance in order to smooth out irregularities of costing due to the nature of the industry, it is inequitable to apply total actual overhead for any one month to the total product for that month. Rather, the underabsorbed overhead in one month is offset by overabsorbed overhead in another month. When the net amount of variation between actual and absorbed overhead is determined at the close of the year, it is too late to recompute all the cost sheets by the use of supplementary rates. Finally, where normal rates are used, the application of supplementary rates defeats the basic concept of normal cost.

No data are available regarding the extent to which industry is using supplementary rates. They are used however, in some instances to spread premium for overtime work over all production. On occasion these rates are called superburden rates, and as many as three of them have been in use in one company at the same time. Again, some companies price inventory at standard, but use supplementary rates for price setting, war contract costing, etc.

## Subdivisions for Overhead Rate Determination

**EXTENT OF SUBDIVISION**—The degree to which subdivision is resorted to in industry for the purpose of setting overhead rates depends largely on the flexibility desired in applying such rates to pro-

duction. Thus, whether blanket rates, departmental rates or cost center rates are resorted to is a matter to be decided in the light of the factors bearing on a given problem. The tabulation below shows general industrial practice in this respect, based upon a recent study (N A C A Bulletin, vol 19)

#### BURDEN RATES BY FACTORY DIVISIONS

Single rate for entire plant	48
Separate rate for each productive department	98
Separate rate for each cost center	52
Departmental and cost center rates	20
Rates by product classes	5
No answer	1
Total	<u>224</u>

**BLANKET VS DEPARTMENTAL RATES**—Use of blanket rates is often a proper method, especially in the case of companies producing a main product in a continuous process (e.g., chemical plant, glass factory). However, some large companies with diversified products are among those using a single rate. The usual point of view regarding blanket rates has been stated by Bennett (N A C A Bulletin, vol 18)

The mill in question used a single percentage on labor for applying mill burden to costs. No I do not believe it is entirely correct, but I likewise believe it is practically speaking satisfactory. It is simply necessary to multiply the standard labor cost for the month as previously determined by the budget mill burden rate and as a result obtain the standard mill burden cost for the month.

On the other hand, Lawrence (Cost Accounting) shows the fallacy of using blanket rates, and the need for departmental rates.

The fact is that the same distribution rate can seldom be used in all parts of a plant because expense is incurred in different amounts and in different proportions by the various producing departments.

To illustrate the necessity for separate departmental rates assume that a certain plant consists of five departments and uses the direct labor hour method of distribution. The manufacturing expense, number of hours and rate of distribution per hour for each department and for the entire plant are as set forth in the following table.

Department	Manufacturing Expense	Direct Labor Hours	Rate per Hour
A	\$ 19 000	25 000	\$ .76
B	20 000	25 000	.80
C	20 000	20 000	1.00
D	18 000	10 000	1.80
E	25 000	20 000	1.25
Entire plant	<u>\$100 000</u>	<u>100 000</u>	<u>\$1.00</u>

A single distribution rate of \$1 per hour for the entire plant would apply all of the manufacturing expense of the plant to its product but as far as each department is concerned the use of the rate of \$1 per hour would apply

- \$6 000 too much to the product of department A
- \$5 000 too much to the product of department B
- The correct amount to product of department C
- \$6 000 too little to the product of department D
- \$5 000 too little to the product of department E

A single distribution rate would give the correct cost only if products were processed for the same amount of time in each department. Since practically every manufacturing concern produces more than one kind of product, and since each product requires more processing in some departments than in others, it must be concluded that separate rates for distributing manufacturing expense should be used for each producing department.

In short, blanket rates have then usefulness

- 1 They are easy and convenient to use for making quick estimates
- 2 Where only one product is manufactured a blanket rate is most practicable
- 3 Blanket rates may also be used where several products are made provided
  - a All products travel through all departments
  - b All products utilize the same amounts of time in each department
  - c The ratio of one product to another remains constant

These conditions must all be present, or the rate becomes invalid. A change in technology may eliminate one or more operations for one product but not another, a sudden shift in demand may cause an increase in demand of one product at the expense of another. For example, some years ago, popular taste in toys turned from rubber dolls to composition dolls. In all such cases, a blanket rate operates to overcost one product and undercost another. If selling prices are based on cost, the public buys the articles offered at the low price (because undercosted) and refuses to buy items offered at high prices. Hence, a factory may work day and night turning out orders at little or no profit or even at a loss, it gets no chance to recoup itself on the rest of the line, since the public refuses to buy.

**DEPARTMENTAL HOURLY COST RATE**—In some cases it is advantageous to combine the direct labor cost in a department with the overhead for the department, obtaining the total cost of operation. This total divided by the number of hours the department is expected to operate yields a departmental hourly cost rate, in effect, an overall rental charge for the use of all facilities in the department. This is the case in the printing industry, where the sold hour rate is used. This rate is a composite of labor and overhead in each department. Expressed as a formula

- $L$  = Estimated direct labor cost  
 $O$  = Estimated overhead  
 $H$  = Estimated hours the department is expected to operate

$$\frac{L + O}{H} = \text{Hourly departmental cost rate}$$

The outstanding characteristics of the system are explained by Miller (N A C A Year Book, 1921, p 143)

- 1 The standard unit of production in the various departments is the productive hour
- 2 The standard hour cost comprises the direct labor plus all overhead expense, departmental and office or general commercial—the gross cost exclusive of stock handling and selling
- 3 The natural divisions of the processes of manufacture form cost centers or departments for the purpose of determining costs



- 4 Average costs for the preceding twelve months are regarded as normal costs
- 5 General factory overhead is distributed over the factory departments on a percentage basis of the total departments' direct expense including payroll
- 6 General commercial overhead is distributed over the various departments on a percentage basis of the total factory cost of departments including payroll
- 7 Depreciation is figured on the original cost of fixtures and machines equipment and installation at 10% per annum, on type at 25% per annum
- 8 Interest on plant investment is figured as a part of costs
- 9 Rental is charged on real estate owned as a part of costs

Departmental hourly cost rates possess the advantage of making possible a simplified calculation for estimating purposes. This is important in the printing industry where cost estimates are the basis of price setting. Also, they are particularly helpful where the ratio between men and machines is not uniform and constant, e.g., a group of men serving several production centers within a department or plant, or one machine tender operating two or more pieces of equipment simultaneously. Church (Overhead Expense) makes the statement that where group working is employed in a department in such a way that a number of similar production centers are served by a group of men working at large, the method of throwing all such semi direct labor into a labor factor and making it part of a process rate effects a considerable saving of time and effort. Costing of this character can be done in no other way so simply and satisfactorily.

**Chargeable Hour Method**—Use of departmental hourly cost rates is illustrated in the photo-engraving industry. In this industry it is called the chargeable hour (or sold-hour) method. The American Photo-Engravers' Association (Manual of the Standard Cost System for Photo-Engravers) explains the method as follows:

For the purpose of arriving at the cost of production of photo engraving the standard unit of cost in the various departments shall be the chargeable hour or hour of work performed on a customer's order.

Costs applied to a job through a chargeable hour rate include the usual factory overhead items, all labor cost (including direct labor), and apportioned selling, shipping and administrative expenses. Items of cost omitted are the key items of raw material such as copper and zinc. Hence, the rate may be termed an all-inclusive one, greatly simplifying cost estimating.

Daily time reports are submitted by all employees engaged on productive work. An important element of the report is the designation of chargeable and nonchargeable time. These time reports are summarized on a monthly record of chargeable and nonchargeable hours and production. According to the Manual, costs are to be ascertained monthly, and by months added together until a period sufficiently long has elapsed to obtain a true average cost covering varying conditions. The final basis is the average for the preceding twelve months. In effect, this constitutes a twelve-month moving average for estimating the actual costs for the coming month. The computation of the chargeable hour rate is illustrated in Fig 18. Fig 19 gives a job cost summary, showing application of costs to the product by the use of this method.

SUMMARY OF DE					
EXPENSE ITEMS	AMOUNT	PERCENT	PERCENT	PERCENT	PERCENT
Fixed Charge Factory Department					55.60
Apprenticed Expense Factory Department					
Factory Wages					88.915
Overhead Supplies					11.748
Miscellaneous Factory Expenses					7.61
Maintenance and Splicing					17.18
Total Department Direct Expenses					11.534
Site Office Gas 1 P. 1. y E power 45.30 per the credit to					
Factory Cost by Department					
Fixed Charge Sell to Supply and Office	11.708	2.447	11.748		
Selling Expense	2130.23				
Shipping Expense		6.164			
Adjusted Direct Expense				2147.07	
Total Selling Expense	2157.35			187.08	
Total Shipping Expense		1.411			
Total Adjusted Direct Expense				2147.07	
Total Department Sell, Ship and Admin Expense 10.30 per the credit to				546.53	
Total Cost by Department					
Noble Charge Sell to 1 P. 1. y E power 11.708 per the credit to					
Total Cost per the credit to 11.708 per the credit to					
STATISTICAL					
Wage Cost per Oh. g. H. H.	11.708 = Cost 101				
Wage Cost per Pay. H. H.	11.708 = 1.201				
Cost per Oh. credit H. H. of N. Oh. g. H. H. 11.708 = 1.201					
Noble Pay. H. H.	11.708 = Total Cost 11.708				
Per Cost Product 1.201	11.708 = 1.201				

Fig 18 Computation of Chargeable

**COST CENTER RATES**—Cost centers (also designated burden centers or production centers) are units, functions, or areas within an establishment that are homogeneous from the cost point of view. A department is an administrative unit. One individual, a foreman, is usually responsible for the management of each department. On occasion a cost center may be identical with a department, but frequently there are two or more cost centers in one department.

A cost center may be a single machine, or it may be a group or battery of machines, all alike as to cost, speed and other operating conditions. A cost center may be composed of a single operator engaged in hand assembly work, or it may be made up of a group of men, if they are engaged in the same work. A cost center may be a single operation, or it may be several operations, if they are reasonably identical in their cost characteristics.

Cost centers are natural divisions of an organization for cost finding purposes. Direct overhead expenses are charged to these centers. Since like work is performed and like cost characteristics prevail in each cost center, the most accurate application of overhead to product results





CAMERA LINE				ETCHING LINE		PROOFING POWER PRESS		LABOR AND OVERHEAD	
12	69	31	2	25	85	69	97	1	25
									1.44
									1.55
									6.15
									4
									1.18
									1
									3.1
									1.15
									2.71
									4.0
									2.34
BEN DAY									
16	69	43		50		87	69	1	1.0
19	69	55		1.05					5.0
									1.0
									5.0
									1
									3.5
									2.5
									0.0
TOTAL COST									
									21.73
PROFIT - LOSS									
BE LED PR CT									
NO PLATES BLOC TO									
NO SUBJECTS STRIPPED									
NO SUBJECTS PRINTED									

Fig 19 Application of Chargeable Hour Rates to Production

stances of manufacture and kinds of operations. Burden centers should be so set up that the burden expense in each will be absorbed in the cost of the product on that basis which so far as practicable most accurately charges such expense.

The formula for the computation of a cost center rate is

$$\begin{aligned} O_d &= \text{Estimated direct overhead for cost center} \\ O_a &= \text{Estimated apportioned overhead for cost center} \\ P &= \text{Production in units, hours or dollars} \end{aligned}$$

$$\frac{O_d + O_a}{P} = \text{Cost center rate}$$

If estimates are in terms of normal cost and normal production, a normal rate is obtained. As indicated in the equation the method for determining the rate may be any of those discussed earlier in this section.

**Illustrative Cost Centers**—A typical list of cost centers for the lithographing industry, suggested by the Lithographers National Association, is given by White (L N A Budget Cost System, 1937)

COST CENTER	BASIS FOR DISTRIBUTION
Raw Stock	Tonnage
Sketching	Man Hour
Art	Man Hour
Engraving	Man Hour
Photographing	Man Hour
Photostating	Machine Hour
Developing and Sensitizing	Man Hour
Hand Transferring	Man Hour
Machine Transferring	Machine Hour
Proving	Man Hour
Plate Graining	Square Inch Area Rate
Stone Grinding	Square Inch Area Rate
Hand Composition	Man Hour
Machine Composition (centers as required)	Machine Hour
Presses (centers as required)	Machine Hour
Bronzeis	Machine Hour
Varnishing Machine	Machine Hour
Embossers	Machine Hour
Cut and Crease (centers as required)	Machine Hour
Stripping	Man Hour
Hand Gluing	Man Hour
Automatic Gluing	Machine Hour
Sheet Straightening	Machine or Man Hour
Straight Cutting	Machine Hour
Die Making	Man Hour
Die Cutting	Machine Hour
Automatic Perforating	Machine Hour
Finishing	Man Hour
Inspecting	Man Hour
Sorting and Wrapping	Man Hour
Packing and Shipping	Man Hour
Ink Grinding	Tonnage
Shipping Case Making	Pound
	Unit

In a "Cost Outline for Narrow Sheet Mills," the Cotton Textile Institute recommends the following cost centers, in this case called departments for cost purposes

#### DEPARTMENTS FOR COST PURPOSES

1 Opening, through Drawing	10 Weaving
2 Slubbers	11 Cloth Room
3 Intermediates	12 Steam
4 Spinning—Warp	13 Power
5 Spinning—Filling	14 Repair Shop
6 Spooling	15 Roll Covering
7 Winding	16 Village and Welfare
8 Slashing	17 Miscellaneous
9 Tying In	

**Extent of Use**—Out of 224 companies, 52 indicated that they were using a separate rate for each cost center. In addition 20 concerns were found using both departmental and cost center rates (N A C A Bulletin, vol 19). Typical of the comments by those using both departmental and cost center rates are the following

In some departments we break down the departmental rate into several rates covering different classes of equipment and operations

We use production center rates in those departments where considerable variation in process equipment exists

Separate rate for each machine tool and separate rate for each department where no machine tools exist such as assembly etc

For example screw machine department is a production department. Within this department we have separate overhead rates for headers, automatic, and hand screw machines

**Cost Center Hourly Cost Rate**—As in the case of the departmental hourly cost rate, it is sometimes advantageous to combine direct labor and overhead costs in a cost center to obtain the total cost of operation, exclusive of direct material. This total, divided by the expected number of hours of operation, yields a cost center hourly cost rate, an overall charge for the use of all facilities in the center. The formula is as follows

$L$  = Estimated direct labor in cost center

$O$  = Estimated overhead in cost center

$H$  = Estimated hours of operation

$$\frac{L + O}{H} = \text{Cost center rate per hour}$$

These rates possess the same advantages that departmental hourly cost rates do. In addition, they are more accurate where diverse operations and equipment are contained within a single department.

In a case study of a Detroit manufacturer, Peden (N A C A Bulletin, vol 20) describes a cost system which combines cost center and departmental rates, some being straight burden rates, others being inclusive cost rates, combining labor and overhead. The company performs two main types of service, coloring of metal parts such as automobile hardware, and the manufacture and assembly of plastic molded parts, such as buttons, levers, and knobs used for automobiles, radios, furniture, and building construction. It was decided that the following direct manufacturing departments should be used as cost centers

DEPARTMENT OR COST CENTER	OVERHEAD BASES FOR COSTING PRODUCT
Polishing	Percentage of Direct Labor Cost
Mixing	Standard Rate Per Pound Mixed
Dipping	Percentage of Direct Labor Cost
Granodizing	Standard Cost per Hundred Pieces
Spraying	Percentage of Direct Labor Cost
Finishing	Percentage of Direct Labor Cost
Plastic Molding	Standard Machine Hour Rate

In the polishing dipping spraying and finishing departments where the labor was more important than the equipment as a cost factor it was decided to charge such labor directly to the detailed cost sheets and to absorb the burden by means of rates based on the direct labor cost. In the mixing department a serially numbered form known as a "batch card" was adopted as a summary of the ingredients of each mix and as a record of the total pounds mixed daily and monthly. It was obvious therefore that in this department it would be accurate and economical to consider all the labor as part of the operating burden and to absorb it into the costs by means of a flat or standard rate per pound resulting from the relationship between the total mixing burden and the total pounds mixed. Similarly in the granodizing room all operating labor was included in the burden accounts and a cost rate per hundred pieces processed was devised. In the plastic molding department where the machines were of a uniform size and type and wage rates were uniform among the machines the operating labor costs were included with the burden and absorbed by means of a single machine hour rate the variations in cost being reflected as factors of the time required for production.

Thus, the rate for plastic molding is, in effect, a cost center hourly cost rate. Some of the other rates are departmental rates on the basis of direct labor dollars. The computation of the plastic molding rate is illustrated as follows:

#### ESTIMATED ANNUAL COSTS FOR OPERATING PLASTIC MOLDING DEPARTMENT

Labor	
Foreman	\$ 100
Operating labor	3 689
Salvage plastic material	190
Total, all labor	\$ 3 989
Repairs	900
Supplies	3 000
Fixed charges	2 411
Apportioned charges	
General factory	2 520
Total cost	\$12 800
Estimated hours	3 200
Hourly cost rate, plastic molding	\$4 00

This inclusive hourly rate is used in determining the product cost on various cost records. Fig 20 illustrates one of these cost sheets. The \$4.00 rate is applied opposite the molding cost in the operation cost section. Note also that finishing burden is applied separately as a percentage of direct labor cost.

**BURDEN RATES BY OPERATIONS**—Patterson describes the application of overhead to the product by use of operation cost rates



DETROIT WOOD CO. MONTHLY PLASTIC COST RECORD						
CUSTOMER <u>STEWART</u> PART <u>ASH TRAY KNOB</u> PART NO <u>134-10 C</u> MONTH <u>MARCH</u> 19 <u>51</u>						
DESCRIPTION	CURRENT MONTH			YEAR TO DATE		
	QUANTITY	COST PER POUND	TOTAL COST	QUANTITY	COST PER POUND	TOTAL COST
Material Cost						
Net 1 Delivered	505 #	70	353 50			
Credit For Sprue	121	45	54 45			
	384	779	299 05			
Credit for Scrap	21	45	9 45			
	363	798	289 60			
Credit For Burn	13	00	00			
Net 1 Mtl Used	350 #	827	289 60			
Production						
Gross	23606	100 0%				
Scrap	2521	107 7				
By Product	87	3 %				
Net	30998	89 07				
NOZZLE SCRAP 10 # - BURNED -						
OPERATION COST	HOURS	RATES	COST	HOURS	RATE	COST
Molding Labor	30	4.00/HR	120 00			
Finishing Labor			100 00			
Finishing & Machine		507	50 00			
Total Oper Cost			270 00			
SUMMARY:-		TOTAL COST	COST PER C PCS			
Material		289 60	1 38			
Operation		270 00	1 286			
Inverts		52 50	25			
Total		612 10	2 915			
Oil Cost		177 90	847			
Total Mfg		790 00	3 762			
S & A 30% OF MFG		167 88	80			
Selling Cost		957 88	4 562			
Profit Or Loss		419 96	2 00			

FIG 20 Cost Record showing Overhead Application Through Cost Center Hourly Rates

(N A C A Bulletin, vol 16) Sales units are converted into operational direct labor hours and dollars, and conversion schedules developed which considerably reduce the amount of detail work. Direct labor dollar is used as a common denominator in applying burden to each operation. In effect, this is merely substituting an operation for a department or cost center. The procedure is the same as in the case of departmental rates. The possibilities of operational rates are explained by Patterson.

It is possible of course to build up these operational burden units on some other measurement than direct labor dollar. For example the machine hour rate is often used. However in this particular business the number of operators on machines is the same for all sizes of commodities produced and such being the case the machine hour rate when developed and applied to speeds for machine hour for certain sizes would work out to the same figure for expense as shown by the direct labor dollar method. It would also be possible to use the units of production and divide the total units into the total expenses for each operation arriving at an average expense cost per unit regardless of size. This is felt to be unfair to the smaller sizes of commodities which go through the machines at a much faster rate than the large sizes.

**RATES BY CLASS OF PRODUCT**—A research study (N A C A Bulletin vol 19) revealed that 5 companies were using separate overhead rates for each class of product. The comments of the reporting individual for one firm are interesting.

Seven rates are used one for each group of sales lines as though made in a separate factory although actually one department may partially process four or five of the seven lines.

Where individual lines of product are processed entirely within their own departments or plants, rates by class of product are, in reality computed by the unit of product method. Where one or more departments process several lines, rates by class of product must be built up using one or more of the methods already discussed. This is commonly the case in process cost plants making a variety of products on a continuous basis (see Section 9 on Process Costs).

**FREQUENCY OF REVISION**—Current practice regarding the frequency of revision of overhead rates is indicated in the tabulation below (N A C A Bulletin, vol 19)

#### FREQUENCY OF BURDEN RATE REVISION

Frequency	Number of Companies
Monthly	7
Quarterly	8
Two to four times a year	3
Semi annually	22
Annually	101
Every two or three years	6
When necessary	37
Infrequent or rare revisions	19
Use actual rates	18
No answer	3
Total companies	<u>224</u>

Thirty seven companies reported that overhead rates were revised only when necessary. The following comments indicate what changes these companies consider important enough to warrant a change in burden rates:

"Every time a major change takes place"

"When necessary due to changes in basic conditions, average once every two years"

"Whenever there is a drastic fluctuation in prices and wage levels"

"Whenever material or labor rates change or there is a change in plant hours"

"When factory layout changes or new facilities are added"

"When made necessary by some such change as a shift in costs from direct to indirect through greater mechanization of operations etc"

"They are calculated to cover a business cycle and are adjusted only when violent production swings change the picture radically"

On the other hand some companies reported infrequent use of change of rates having used same rate for periods up to 15 years. The reason generally assigned is the fear that the basis of comparison would be destroyed by more frequent rate changes. However over 80% of the companies studied have a regular plan for reviewing their overhead rates.

**JOURNAL ENTRIES**—The exact form of entry or entries on the books of account for costing of overhead depends upon

- 1 Type of cost system in use
- 2 Classification of accounts employed
- 3 Manner in which overhead is applied to product

If actual overhead is applied to the product at the close of the period, the entry takes the following form

Work in Process	\$	\$
Manufacturing Expense		
To charge actual overhead for month to Work in Process		

If a predetermined amount of overhead is applied to product, the costing entries at the end of the month are

Work in Process	\$	
Absorbed Expense		\$

To charge Work in Process with amount of overhead costed to product during month

Absorbed Expense

Underabsorbed Expense

    Manufacturing Expense

To establish the amount of underabsorbed overhead for the month

If expense is overabsorbed, the amount is credited to **Overabsorbed Expense**. Ordinarily, under- and overabsorbed expense are carried until the end of a fiscal period. At that time the balance may be closed into Cost of Sales, Profit and Loss apportioned against Cost of Sales and inventories on a percentage basis, or thrown into a reserve account. (See discussion later in this Section.)

**SUMMARY OF OVERHEAD FORMULAS AND SELECTION OF METHOD**—Fig 21 summarizes the methods of computation.

METHOD	FORMULA	WHERE USEFUL
1 Direct Labor Dollar Method	$\frac{\text{Overhead}}{\text{Direct labor dollars}}$	Labor the main productive element no material pay rate differences
2 Direct Labor Hour Method	$\frac{\text{Overhead}}{\text{Direct labor hours}}$	Labor the main productive element pay rate differences preclude using (1)
3 Machine Hour Method	$\frac{\text{Overhead}}{\text{Machine hours}}$	Machines the main productive element must no uniform relationship between machine time and main time
4 Unit of Product Method	$\frac{\text{Overhead}}{\text{Number of units of product (each weight points)}}$	One product mass produced or a few products of great uniformity that can be selected by weight or by a point system.
5 Material Cost Method	$\frac{\text{Overhead}}{\text{Direct material cost}}$	Most useful to apply material burden also in special departments and for special processes of materials
6 Prime Cost Method	$\frac{\text{Overhead}}{\text{Direct material cost} + \text{Direct labor cost}}$	In special situations only material and labor costs, together should follow a uniform pattern considered as required
7 Market Value Method	$\frac{\text{Market value product A}}{\text{Total market value all products}}$	For joint products.
8 Supplementary Rates	$\frac{\text{Actual overhead} - \text{Absorbed overhead}}{\text{Hours dollars or units}}$	To obtain actual overhead cost for product where a predetermined rate has been used to modify costs during period without changing main rates
9 Blanket Rates	$\frac{\text{Total overhead for plant}}{\text{Total hours dollars or units}}$	Where one product is made in continuous process where a few related products are made involving the same time and effort at each stage
10 Departmental Rates	$\frac{\text{Direct department overhead} + \frac{\text{Apportioned overhead}}{\text{Hours dollars or units for department}}}{\text{Hours dollars or units for department}}$	Where diverse products are made where differences in processing occur

ing rates for the application of overhead, and the conditions advantageous for their use. Certain points may be listed as guides in selection of correct method for application of overhead to product in specific cases:

- 1 Method selected should use as its base the main productive element in the particular manufacturing operation, i.e., it should relate indirect factory expenses to the product in a logical way.
- 2 Separate rates should be established for each area that constitutes a homogeneous cost unit from the point of view of obtaining correct product costs. In some cases this may mean cost center or operation rates in others blanket rates.
- 3 The method should eliminate from product cost unwarranted fluctuations in unit costs occasioned by radical volume changes. In some companies this problem may not exist in excessive form and actual or an estimate of actual rates may suffice. In a majority of companies normal rates are necessary.
- 4 The method or methods adopted should make possible monthly profit and loss statements of operating significance as well as facilitate the compilation of special reports.
- 5 Other things being equal departmental rates or cost center rates are superior to blanket rates because of the greater flexibility of the former.
- 6 Other things being equal rates based on time (labor hours machine hours, etc.) are preferable to rates based on a variable cost factor (labor dollar material cost, etc.). This is because many important expense items, particularly fixed charges, are functions of time (depreciation fire insurance, rent, etc.) and cost factors may not move in step with changes in overhead.
- 7 The method adopted should be practical, but not so "practical" as to give the wrong cost data, nor so simple as to yield information of no use.

In the final analysis, the method of applying overhead to the product must be tailor-made for each organization.

**EFFECTS OF DIFFERENT METHODS**—Halligan (NACA Bulletin, vol. 19) points out some wide fluctuations in unit costs that can result from different methods of applying overhead. The industry in question manufactures mechanical rubber products. He states:

It has been my pleasure to survey cost systems used in one branch of the mechanical goods industry known as the molded goods group. Among the forty manufacturers investigated I found several different methods of applying overhead to the cost of product:

- 1 The poundage basis.
- 2 The prime cost basis. That is overhead is applied in relation to the combined material and direct labor values in each product.
- 3 Total direct labor dollar basis. That is the total direct labor cost of each product is used as a basis for applying overhead.
- 4 Departmental direct labor dollar basis. That is separate overhead rates were used for each operation, based on the direct labor dollar method.
- 5 The machine hour method. Some companies follow the plan of applying all overhead in the entire plant on a machine hour rate depending upon the curing time at the press.
- 6 Lastly what we recommend as the correct method, departmental rates using direct labor dollar method as a basis in all departments except those where the direct labor time does not correspond with the machine time.

I have calculated the total production costs for two products A and B using each of the methods listed above. The following figures illustrate the wide fluctuations in cost that can result from differences in the method of applying overhead to the product.

Method	Cost per 100 Pieces	
	Product A	Method B
1	\$ 1457	\$35 87
2	2368	20 43
3	2659	17 99
4	2237	30 68
5	2187	30 49
6	2608	20 93

**DISPOSITION OF UNDER AND OVERABSORBED EXPENSE**—Absorbed overhead is the amount of overhead expense costed to the product through the use of overhead rates (e.g. rate per direct labor hour). When these rates are based on an estimate of actual expense for the coming period some difference results between the amount of actual overhead expense, and the amount costed to product. The monthly differences may be of considerable size due to seasonal factors, but for the year as a whole the difference should not be great. If absorbed overhead is greater than actual, it is called overabsorbed overhead, if less, it is called underabsorbed overhead. The amount of over- or underabsorbed overhead is determined monthly by departments by comparing the total overhead applied to production with total actual overhead, these differences are accumulated as the year progresses. Under ordinary circumstances the monthly differences are carried forward, and only the year-end amount of over- or underabsorbed overhead needs disposition.

Disposition of this final balance rests on surrounding circumstances. If the amount is small the customary procedure is to carry it to Profit and Loss, and to show it under **Other Deductions** or **Other Income** on the profit and loss statement. A low balance of over- or underabsorbed overhead indicates that the original estimates were fairly accurate. If amount of over- or underabsorbed overhead is large, it indicates that the original estimates of overhead and production were greatly in error. In this case, adjustments of cost of sales and of inventories may be made, the total of over- or underabsorbed overhead being distributed to each item in the ratio that the overhead cost has already been applied to them.

When it becomes evident during the year that the difference between absorbed overhead and actual overhead will be excessive by the close of the period, some concerns compute **supplementary rates** to use along with the regular overhead rates set at the beginning of the period. Others adopt the policy of changing their regular overhead rates at any time during the period it becomes evident that they are "out of line." In connection with this step, the previous monthly balances of unabsorbed overhead may be closed to profit and loss. (See Section 20 for further presentation of this topic.)



## SECTION 20

### OVERHEAD AND NORMAL CAPACITY

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## SECTION 20

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### OVERHEAD AND NORMAL CAPACITY

#### Normal Capacity

**CONCEPT OF NORMAL OVERHEAD**—The basic concept of normal overhead is that the actual cost is not necessarily the best criterion of the true cost but that the proper amount of overhead expense to be charged to the product is the amount incurred at normal capacity. Two elements are thus involved:

- 1 Normal production, involving a determination of normal capacity,
- 2 Normal expense, involving a computation of normal burden rates.

**DEFINITIONS OF NORMAL CAPACITY**—Three definitions of normal capacity are presented below, giving expression to various concepts:

- 1 The normal capacity basis is the total possible time (that means any kind of work machine or other), less reasonable allowances for breakdowns, repairs, inefficiencies, reasonable lack of operators and all other regular normal delays outside of lack of orders to run (N.A.C.A. Year Book 1921 p. 241).
- 2 Normal capacity is the utilization of physical plant that is necessary to meet the average commercial demands over a period of time long enough to level out the peaks which come with seasonal and cyclical variations (Charles C. James N.A.C.A. Bulletin vol. 16).
- 3 It is believed that normal capacity should be considered as capacity both to make and sell and should be based upon anticipated sales for a term of years in the future—the term of years to approximate the average period required for the realization of fixed investment (J. B. Heckert N.A.C.A. Year Book 1939).

While it is possible to speak of maximum physical capacity and potential operating capacity as figures for a specific period of time, such as a month, frequently it is desirable to think of these terms as averages for a longer period. For example, an average for a year smooths seasonal fluctuations. This is illustrated in the Manual of Job Cost Finding Practice for Miscellaneous Jobbing Steel Foundries issued by the Steel Founders' Society of America in which average or normal rates are recommended for costing burden.

Average or normal costs means those representing average conditions of business and they should always be used for establishing the overhead rates necessary for determining actual and estimated costs of individual castings. This is true whether or not the average costs are higher or lower than the actual prevailing costs of carrying on the business during the various fluctuations in the rate of operation of the foundry caused by

changing conditions of general business. Therefore the overhead rates for use in obtaining costs of individual castings must be computed from a summary of costs representing high medium and low rates of operation of the foundry.

No fixed rule exists for determining the number of years entering into the composition of a normal rate. It should take into consideration the fluctuating plant operations with respect to general business conditions in an effort to arrive at a figure for normal operation. The latter, according to the source mentioned above, represents the average production for a complete business cycle, and in calculating normal production costs some forecast of plant operations for the next business cycle should be made. In this way normal costs reflect actual or anticipated changes in classes of work or volume of operations. Thus the concept of normal costs is bound to change with the times. Manufacturing industry is going through great changes at a constantly accelerating rate, in developing new raw materials, new improved processes, automatic equipment, etc. With the onset of the war a new cycle has started and there is no reason to doubt that what was normal some years ago must give way to a new basis of values and standards in establishing normal overhead for the period ahead.

**PURPOSE OF NORMAL CAPACITY**—The purposes of normal capacity may be listed as follows:

- 1 To serve as a basis for applying normal burden rates
- 2 To assist in forming price policies, both immediate and long run
- 3 To value inventories
- 4 To help plan sales and production and in so doing to assist in establishing plant balance
- 5 To help in determining the profit realization point
- 6 To help in showing profit and loss by commodities on a more accurate basis
- 7 To assist in a cost reduction program

Comments on some of the above points are stated below.

**Normal Burden Rates**—The disadvantage of applying actual overhead, or an estimate of actual to the product, lies in the fact that wide fluctuations in unit costs are caused by variations in the volume of production from one period to another. This is due to the behavior of the fixed charges contained in the total overhead expense. Use of a normal overhead instead of actual, to apply to production has the great advantage of eliminating from unit costs those fluctuations due to changes in the volume of output. In this way it becomes easier to discover changes in costs caused by other factors and to determine their extent. This fact has been recognized by business leaders everywhere for a long time. There is a general recognition of the fallacy of a costing scheme which produces high costs in periods of falling production and low costs as production rises. Such costs are generally considered incorrect, unsound, and unsafe in providing a basis for a well-considered manufacturing or financial policy. The use of normal burden rates is the answer to this problem because of the stabilizing effect they produce on costs.

**Profit Realization Point**—Regarding the determination of the profit realization point, James (N. A. C. A. Bulletin, vol. 16) says

The concept of "profit realization" or "break even" point is one of the most useful that has entered the practice and procedure of modern budgeting. In practical application it calls for the determination of the point where income and expense balance. Below that point there is a loss above that point a profit. It is clearly evident that this profit realization point which is usually expressed in sales volume corresponds to a certain amount of product at certain prices. This volume of product is a certain determinable part of plant capacity. That is to say, from our capacity point of view, the plant is burdened in each of its divisions with fixed charges which in turn demand a definite output in order to supply a volume of product whose sales income will exactly balance expenditures.

Volume of production necessarily is affected by price levels that are influenced by outside competition. Lower prices may increase production volume indeed they may bring utilization very close to operating capacity and yet because of low prices the break even point may become so high that profits are not realized. In contrast our price level may be too high with corresponding smaller volumes and greater idle capacity costs. Here again we find the break even point too high for a favorable profit condition.

This interplay of prices, costs, volumes and capacities calls for nice measurement on the part of management.

**Profit Lines and Cost Reductions**—Regarding the advantage of showing profit and loss by commodities as a part of a cost reduction program Patterson (NACA Bulletin, vol 16) has the following to say:

The cost reduction possibilities of standard burden rates are tied up largely with the commodity profit and loss statement which presents in final form the profit or loss picture for each major commodity sold. Unabsorbed burden is shown therein separated into that portion due to spending more than the budget allowed and the portion due to idle plant facilities. This information is helpful in cost reduction programs. While manufacturing expense is controlled as a whole through the manufacturing expense budget, the commodity profit and loss statement, if properly set up, serves to call attention to the need of additional pressure to be brought to reduce expense in connection with the manufacturing of certain commodities. In other words, commodity profit and loss serves to shed additional light on the matter of expense controls and from a different angle as compared to the expense budget thus permitting of closer control of expense than is possible through the use of the manufacturing expense budget alone.

**NORMAL CAPACITY BASES**—There are two general points of view regarding the method of determining normal capacity:

- 1 Normal capacity should be based entirely on ability of a plant to produce. This is potential operating capacity also sometimes called practical capacity.
- 2 Normal capacity should be based on expected utilization of plant to meet expected sales over a period of years in the future. This is normal sales expectancy it has also been called average capacity.

While the term "normal capacity" is applied to the results derived under both of these procedures, it is better to refer to "practical plant capacity" in the first case, and "capacity based on normal sales expectancy" in the second.

**Extent of Use of Normal Rates**—In a recent study (NACA Bulletin, vol 19) it was found that 60% of companies covered are using normal capacity for costing overhead, and of these, 78% use concept of

capacity based on sales expectancy (ability to produce and sell), 40% of all companies use either actual overhead, or an estimate of actual for the coming year.

In a more recent research study (N.A.C.A. Bulletin, vol 22) practically identical results were reported regarding the extent to which normal rates are used, 61% of all companies were found using normal rates. Since there is little duplication of concerns included in the survey, the results appear conclusive.

In the same study, members with companies using normal capacity were questioned regarding recent increases in their normal capacity figures. Of 154 companies using normal capacity, 55 stated that they had increased their capacity level recently, and 40 reported the approximate increase.

**Capacity to Make vs Capacity to Sell**—Use of practical operating capacity seems the more logical where the productive capabilities of installed equipment are well adjusted to customers' requirements and sales possibilities. In such case the practical operating level and the normal sales expectancy are approximately on a par with each other, and major differences tend to disappear. Use of capacity based on normal sales expectancy is favored by companies whose sales fluctuate violently, quite frequently this procedure is favored also by concerns which are overequipped. However, if excess capacity costs are closely computed and eliminated from the burden to be applied, the rates obtained by using normal sales expectancy do not differ greatly in most instances from those obtained by using practical plant capacity. The crux of the matter lies in the disposition of the fixed charges constituting excess capacity costs.

In practice, these two points of view merge in many cases consideration being given both to practical capacity and to sales expectancy. This is shown by the comment received from one concern relative to its method (N.A.C.A. Bulletin, vol 19):

This question must be considered in two stages. anticipated sales for the period under review, anticipated sales for a term of years in the future, and average sales for a number of past years are considered together and a normal sales quota obtained. practical capacity of the plant as a whole and practical capacity of the department with least capacity are considered together and matched with the sales quota above. From this comparison is obtained a reasonable normal capacity upon which burden rates are computed.

A recent study shows that companies using ability to produce as a base list the practical capacity of the plant as a whole as a factor of primary importance (N.A.C.A. Bulletin, vol 19). In the case of companies basing normals on sales expectancy, there is no agreement on a single factor of primary importance, although a majority of plants emphasize practical capacity of the plant as a whole.

**Capacity Relationships**—The chart in Fig. 1, adapted from one appearing in an article by James (N.A.C.A. Bulletin, vol 16), illustrates the major relationships involved. The maximum possibility or theoretical capacity of a plant or department to produce would be that achieved under 100% operating time. This involves no limitation for

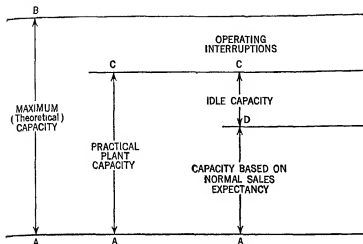


FIG 1 Capacity Relationships

waits and delays of any character, and is not achievable. In Fig 1 it is represented by the line *AB*.

Practical plant capacity is maximum capacity less operating interruptions and is shown by the line *AC* in Fig 1. This represents practical utilization of the physical plant, without regard to commercial demands. Operating interruptions to be considered include, according to James:

Time lost for repairs, waits, breaks, set ups, make readies, clear aways, machine failures, organization slips, unsatisfactory materials, delays in deliveries of raw materials from suppliers, labor fall downs and absences. Allowances for operating interruptions vary between 15% and 25% of maximum capacity. Hence, from the point of view of capacity to make, normal capacity is 75% to 85% of the theoretical maximum, depending on the nature of the industry and the circumstances surrounding the particular case.

Idle capacity (line *DC*, Fig 1) is the unutilized portion of the plant and equipment, due to lack of customer demand. Capacity based on sales expectancy (line *AD*, Fig 1) is measured by the productive equipment required to meet the average commercial needs over a period of time. On the chart, this is the difference between practical operating capacity and idle capacity.

The determination of normal capacity is illustrated by James, cited above:

An extreme example is found in the machine tool builders' industry. As J. M. Clark points out (*Economics of Overhead Costs*) if we take average replacement requirements of their customers as a base of 100 actual de-

## NORMAL PRODUCTION CAPACITY

Schedule of production hours	365
Total days in year	69
Less 52 Sundays, 11 holidays, and 6 days inventory closing	296
Schedule working days for year	8
Average hours per day (5 at 8% 1 at 4%)	2 368
Annual schedule hours—gross	189
Machine repairs adjustment and overhauling—8%	2 179
Net annual schedule hours	

Fig 2 Normal Production Hours

## MACHINE CAPACITY—NORMAL SCHEDULE

Kind of Cigar	Number of Machines	Production per 8% Hour Day	Production per Hour	YEARLY MACHINE PRODUCTION	
				Normal Net Schedule 2 179 Hours per Machine	Annual Production (Thousands)
Blk Londres	22	4 000	457 1	47 938	21 912
Perfecto	8	4 000	457 1	17 432	7 968
Cabinet	78	4 000	457 1	169 962	77 690
Panetela	4	4 000	457 1	8 716	3 984
Endicott	12	4 000	457 1	26 148	11 952
Midget	22	4 000	457 1	47 738	21 912
Junior	8	4 000	457 1	17 432	7 968

Fig 3 Computation of Normal Machine Capacity

mands for new equipment fluctuate from plus 300 to minus 100. While the machine tool builders never completely stop operations, nor are they equipped to meet super normal demands with prompt deliveries, the average use of their manufacturing facilities ranges between 50% and 60% of potential capacity. From this it follows that a machine tool builder is operating at normal whenever he is turning out a little over half of what he is equipped to produce.

This would indicate that from the point of view of capacity to make and sell, normal capacity might run as low as 40% of maximum plant capacity. It could be less, and in some cases it might run as high as 85% of theoretical maximum.

**Practical Capacity**—Many types of plants use practical capacity as a basis for setting normals. A few are illustrated below. Thus, use of normal capacity based on the practical operating level in cigar manufacture is discussed by Knapp (N.A.C.A. Bulletin, vol. 14). Fig. 2 shows computation of normal capacity (in hours per year), with an 8% deduction from the theoretical maximum for operating delays. The resulting figure is applied to the number of machines available for producing different shaped cigars (Fig. 3). Multiplying the production per hour for each machine by the normal number of hours as determined in Fig. 2, gives normal capacity for each kind of cigar, expressed in units of physical product. For cabinet cigars, 78 machines  $\times$  457.1 production per hour  $\times$  2,179 normal hours per year = 77,689,630 cigars normal capacity on a practical operating level.

These figures are then converted into departmental normals, by computing pounds of tobacco and labor cost for the normal production. Normal expenses are estimated from departmental budgets on the basis of a departmental production schedule. Then, normal expense divided by standard direct labor obtained from production schedule yields the normal rate in per cent of direct labor cost.

The Lithographers National Association, in its LNA Budget Cost System, also advocates use of practical capacity for setting normal rates.

The budget cost system of the lithographing industry is based on the

department

In the definition of cost for the hosiery industry's code of fair competition, normal volume is indicated as follows (N.A.C.A. Year Book, 1934)



1 From the 52 80 hour weeks of the year or other provision for the operation of productive machines as may be provided by amendment to the code deduct legal holidays and the time allowed for taking inventory in order to determine the maximum possible time that the knitting departments would be devoted to production and express the result in terms of total productive hours

2 Compute total maximum production that the knitting departments are capable of accomplishing in the total productive hours and consider this the maximum capacity of the mill

3 Normal capacity will be stated as 75% of maximum capacity. The deduction of 25% is to provide for loss of time due to break down pattern changes making samples seasonal fluctuations and other causes. In any case where a mill's total production has exceeded 75% of the maximum capacity for the previous fiscal year the actual percentage of maximum capacity so attained may be used in place of the 75% otherwise specified

The figure of 75% of maximum is also recommended by the trade association for the knitting industry. It suggests an estimate of the quantity of production that can reasonably be expected in the productive time available. The manual computes maximum capacity at 3872 hours per year.

In the electrical manufacturing industry the following concept of normal capacity was contained in the Code of Fair Competition under the N.R.A.

Normal volume may be computed most appropriately in relation to the capacity of the equipment available for production in the plant that is the installed equipment after making allowances for excess facilities as defined below.

All computations of normal volume are predicated on the operation of the plant on a single shift basis that is on the number of hours per week (or per month or year) worked by the employees (unless for example, the normal or established practice in a particular branch of the industry is to operate the plant on other than a single shift basis).

A plant has a theoretical capacity that is a capacity to produce at the full speed of all of its equipment and without interruption from any cause. The reduction must be made for those factors that result in a rate of production at less than theoretical capacity. This reduction must include allowance for the stoppage of the machine for normal causes such as renewing the supply of material, removing the finished product, adjusting the machine, etc.

Other allowances must be made such as no operators or material available for machines, machines stopped for repairs or because of no power or steam and machines stopped because of delays incident to the production of imperfect goods. In other words, theoretical capacity should be reduced to the extent necessary to take into account all causes of idleness except a shortage of orders.

The amount of reduction from theoretical capacity to normal capacity as here used varies, of course, from plant to plant but it is usually found that the amount of allowance is 15% to 20% and may be more.

**Sales Expectancy in Industry**—Use of capacity to sell as a basis for normal burden absorption in the linoleum industry is explained by Patterson (N.A.C.A. Bulletin, vol 16) who describes the steps necessary in arriving at normal volume for the application of manufacturing expense.

First, there is determined what has been called 'potential operating capacity,' i.e. the capacity to make taking into consideration the necessary allowances for the machine changes, and for other down time.

Second the normal sales figures are estimated. These normal sales are usually tied in with the sales for the industry as a whole. It is necessary to come to some conclusion as to the relative position this business has in its industry which may be based on relative capacity to produce, or upon a demonstrated ability to sell. The trend in general business and in the particular industry is then determined and a forecast made of the probable normal sales volumes for a period of possibly three to five years. The percentage of the total industry represented by this business is then expressed in sales units which will be the normal sales volume.

The normal sales volumes thus arrived at may be thought of as burden absorption points. In the business under consideration these figures are set yearly and the volumes are not changed until there is an authorized revision of either the capacity or the burden absorption points.

At this time the comparison of production and sales possibilities shows the following:

	Capacity Units	Normal Sales Units	% Normal Sales of Capacity	Budgeted Volumes (Units)
Commodity A	1,500,000	1,000,000	66 7%	750,000
Commodity B	2,000,000	1,000,000	50	600,000
Commodity C	500,000	350,000	70	250,000

It should be noticed that the figures listed under "normal sales" are the average expected sales for a period of from three to five years while the figures under "Budgeted Volumes" are an estimate of the sales for the next twelve months and may vary considerably from the normal sales forecast. The procedure in this particular business is to accept the normal sales volume as the basis for burden absorption inventory valuation and for routine estimates. However the sales manager is given cost information for catalog items which show the total cost absorbing all factory burdens at the forecast volume. This particular information can be developed quickly from standard costs at normal sales volume.

In the cost manual of the malleable iron industry the following statement is made with reference to the procedure to be used in order to determine the amount of fixed plant charges and administrative and selling expense to be redistributed:

"Normal Operations" of the individual producer for any semi-annual accounting period shall be determined by taking not more than 65% of the best six consecutive months' production of such individual producer ("practical capacity"), and for any quarterly accounting period one half of such amount.

Determine the percentages which production of the individual producer for the last preceding semi-annual or quarterly accounting period is of normal operations for the same length of time. Distribute this percentage of total fixed plant charges for the same accounting period adjusted to a basis of normal operations as follows (when not severally departmentalized): 10% on the basis of pounds of metal poured (melting department expense); 40% on the basis of molding direct labor, 10% on the basis of coremaking direct labor, 10% on the basis of the combined grinding and finishing direct labor and 30% on the basis of the weight of good finished casting produced all for the same semi-annual or quarterly accounting period to determine the amount per ton or percentage, as the case may be, to be added to the respective departmental indirect costs.

Determine the percentage which production of the individual producer for the last preceding semi-annual or quarterly accounting period is of normal operations for the same length of time and distribute this percentage of the total administrative and selling expense for the same ac-

counting period adjusted to the basis of normal operations on the basis of manufacturing cost for the same semi annual or quarterly accounting period

In line with the above are the cost accounting provisions for the washing machine industry (N A C A Year Book, 1934)

In establishing the basis of normal productive capacity the ratio of the average annual sales volume in units (using a five year period) of the industry will be determined in relation to the maximum production volume in units possible if the available facilities for manufacture in the industry were operated for a 50 week period at a 40 hour week. This ratio or percentage of average volume to maximum volume will be applied in each of the companies to their maximum volume expressed in direct labor dollars (productive labor  $\times$  average current wage rate) in order to arrive at the normal productive labor to use as the basis in determining the ratio of budgeted fixed factory burden

In a research study regarding the calculation of normal capacity, company comments relative to specific methods followed in setting normal capacity show considerable support to the approach based on sales expectancy. Some of these comments are (N A C A Bulletin, vol 19)

1 Our plant is divided into separate manufacturing units each of which produces its own costs and stands on its own showing in the final profit and loss statement. Our normal capacity therefore, is dependent upon what each department expects to be able to sell.

2 This plant is well balanced and volume fluctuations from year to year are less than in most industries. For this reason the estimated sales for the year under review are used as a basis for the production estimates for burden rates with this same modification for plant capacity.

3 Generally speaking, our standard costs are based on our sales expectancy, but where sales expectancy is very much less than potential machine capacity and where costs based on sales expectancy would over value inventories and produce a cost greater than the selling price we use costs based on capacity to produce separating all excess depreciation management and building service charges and charging them to an account called Unoperated Factory Expense charged to Profit and Loss.

4 Our method of determining normal capacity is based upon the average cycle of sales volume for the past five years. Our sales department refused to estimate possible future sales as they claim they cannot measure the possible economic factors that will influence the sale of our product. It is necessary therefore to leave them out of the picture and apply known factors with forecasts of economists to establish a basis for computation.

5 The sales average for the past eight to ten years establishes our normal. This average is converted into the productive hours which are required to produce the volume. This constitutes our normal capacity.

**EXCESS CAPACITY**—Excess capacity results from two conditions

- 1 Capacity to produce more than the business can reasonably hope to sell
- 2 Unbalanced machines or processes

Excess capacity is determined in relation to peak demand. According to James (N A C A Bulletin, vol 16)

Peak demand capacity is the utilization of plant and equipment during a specified period of time to meet the maximum commercial demands for the products of the plant. This peak demand capacity may be more or

less than potential operating capacity. If it is greater, the peak demand must be met through overtime operations, extra shifts or delays in delivery. If the capacity required to meet peak demand is less than potential operating capacity the difference represents excess capacity.

Excess capacity may therefore be defined as operating capacity which is over and above peak demand capacity. It is that part of idle capacity which is not utilized even at the time of maximum demand.

**ADVANTAGES OF EACH METHOD OF CAPACITY DETERMINATION**—Each method of capacity determination has its definite advantages. Thus, according to Schlatter (Advanced Cost Accounting), capacity based on sales expectancy offers the following advantages:

- 1 It spreads fixed costs of all equipment over the production on the basis of long term estimates. Thus it accomplishes for cyclical trends of five to nine years what estimates of one year accomplish for seasonal operations. It is the most widely used method.
- 2 It appeals to the practical minded management, business executives see rates so obtained as applying all costs to the product over a long sweep.
- 3 Where costs of excess equipment are excluded the differences between the two approaches become less marked.

On the other hand, capacity based on practical operating level possesses the following advantages:

- 1 Use of practical capacity gives more accurate unit costs so far as the burden element is concerned, a cost which does not include any part of expense for excess or idle plant capacity.
- 2 Fixed costs of unused capacity are more accurately stated.
- 3 Inventories are more conservatively stated.
- 4 Comparisons of cost and volume variances over a long period of time and between companies, are more meaningful.

**EFFECT OF FLUCTUATING VOLUMES ON COSTS**—The relative effect that some of these concepts have on unit burden costs is illustrated in "Normal Capacity and Its Relation to Costs" issued by the Illinois Manufacturers' Cost Association, as follows:

#### NORMAL CAPACITY AND COST

Factory Operating Condition	Monthly Production in Units	Unit Burden
1 Practical capacity	1,000	\$2 00
2 Highest sustained rate of production (experienced for one month during year)	900	2 22
3 Average production over several months of regular operation when sales volume was sufficiently uniform to warrant efficient operation	800	2 50
4 Monthly production during a year when most uniform production was maintained throughout the year	700	2 85
5 Average monthly production during previous year	600	3 33

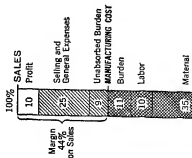
The range of operating conditions illustrated above is from practical capacity to an estimate of actual. Capacity based on sales expectancy might be located at any point between these two. In its bulletin, the

# COMPARATIVE RESULTS OF INCLUDING BURDEN IN MANUFACTURING COST AT THE LEVEL OF (1) CAPACITY TO MAKE AND (2) CAPACITY TO MAKE AND SELL

Assuming capacity to sell is 60% of capacity to manufacture and the operations actually attain 90% of the capacity to sell

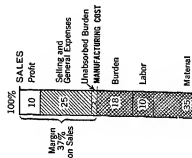
## I

Composition of Sales Dollar with Burden in Manufacturing Cost at the Level of Capacity to Make



## II

Composition of Sales Dollar with Burden in Manufacturing Cost at the Level of Capacity to Sell



## III

What happens when Burden is included in Manufacturing Cost at the Level of Capacity to Manufacture but the Margin obtained is that which would be suitable only if Burden were included at the Capacity to Sell

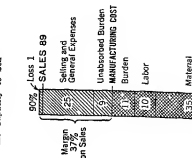


FIG 4 Graphic Comparison of Normal Capacity Bases

association states that after considering all elements normal capacity should be set as a compromise between (1) and (5)

Camman (Basic Standard Costs) discusses the effect of normal capacity on costs from a different viewpoint

If the normal level is set at capacity to manufacture the unabsorbed burden variation will consist of an amount corresponding to the difference between the capacity to make and the capacity to make and sell, plus an amount proportionate to any failure to realize the expected sales. Whereas if the normal level is set at capacity to make and sell unabsorbed burden will be confined to the amount proportionate to the sales not realized.

Of course in the last analysis the difference in the two methods is

Machine Number	Description	Maximum Use	Required Economical Use	Peak Demand	Excess Machine Time	Normal Use
Group 1						
101	American Engine lathe 18 x 12	40	40	24	16	18
109	American High Duty lathe 18 x 12	40	40	24	16	18
110	American High Duty lathe 16 x 12	40	40	24	16	18
		120	120	72	48	54
Group 2						
305	Meriden Forming lathe 18	80	20	10	10	8
Group 3						
308	American Turret lathe 24	36	24	18	6	14
350	American Turret lathe 24	20	24	10	14	7
		56	48	28	20	21
Group 4						
311	Fay & Scott lathe 18	40	40	16	24	14
312	Fay & Scott lathe 18	40	40	10	24	18
314	Fay & Scott lathe 18'	24	40	0	40	0
372	Fay & Scott lathe 18 x 6	40	40	40	0	27
		144	160	72	88	54
Group 5						
415	Dresser lathe 20'	72	40	36	4	27
Group 6						
316	Gisholt lathe 20	40	40	24	16	18
317	Gisholt lathe 20	40	40	24	16	18
318	Gisholt lathe (style H) 21	24	40	12	28	9
319	American lathe 24 x 32	24	40	12	28	9
320	Lobby lathe 26	60	40	80	10	23
325	Gisholt lathe 21	60	40	20	10	27
351	Lobby lathe (type A) 18 x 16 8	60	40	30	10	28
352	Lobby lathe (type A) 18 x 16 8	60	40	30	10	22
		288	240	144	60	144
Group 7						
373	Acme Flat Turret lathe 3 1/2" x 80'	44	40	40	0	22
329	Acme Flat Turret lathe 3 1/2" x 86	40	40	0	40	0
337	Acme Flat Turret lathe 3 1/2" x 86	40	40	22	18	18
338	Acme Flat Turret lathe 3 1/2" x 86	40	40	40	0	23
339	Acme Flat Turret lathe 3 1/2" x 86	40	40	0	40	18
		204	200	102	98	78

FIG 5 Weekly Productive Hours of Machine Tool Use

merely in what amount shall be included in manufacturing costs and what amount must come out of margin. But when the lower burden basis is used, there is a risk that it will be forgotten that due provision must be made in the margin for any failure to attain full manufacturing capacity if profit is to be maintained. The distinction in calculation and the effect if it be overlooked are brought out graphically in the diagram (Fig 4)

**UNITS OF MEASUREMENT OF PLANT CAPACITY**—Plant capacity may be measured in terms of

- 1 Units of physical product
- 2 Time of productive effort
- 3 Dollars

Where there is uniformity of product, it is convenient to express capacity in physical units, e.g., barrels of flour in a flour mill, tons of rail in a rail mill, pounds of good castings in a foundry, pounds of wool in a woolen mill, tons of run-of-mine coal at the mouth of the shaft in a coal mine, gallons of pulp from beaters in a paper mill. Where there is a variety of product made from a diversity of raw materials, the productive hour serves as common denominator for measuring plant activity. This is illustrated in a machine shop (Fig 5, N A C A Bulletin vol 16) in which various sizes of non-steel, and brass castings are fitted into valves, pumps, and hydrants. The following explanations, taken from James, cited earlier, apply to Fig 5.

Maximum use is the number of hours per week each machine will be in operation when the company's foundries are running at their maximum capacity, i.e., 6 heats a day.

#### MACHINE TOOL EXPENSE RATE

	Total	Standard	Excess
Fixed charges			
Depreciation of machinery	\$17 62		
Depreciation of building	99		
Maintenance of machinery, equipment and building real estate taxes insurance and watchmen	16 13		
Total weekly expense	<u>\$34 74</u>		
Apportionment to standard cost 72/120 of \$34 74		<u>\$20 84</u>	
Remainder to excess plant expense			<u>\$13 90</u>
Machine tool expense—hourly \$20 84 a week — 54 normal hours a week		\$ 40	
Power			
101 D C 204 kw at \$ 045 per kwh	0918		
109 A C 230 kw at 033 per kwh	0759		
110 D C 255 kw at 045 per kwh	11475	004 aver	
Supervision and other overhead distributed on basis of standard productive hours		675	
Direct labor pay per standard productive hour		<u>54</u>	
Standard processing cost per productive hour		<u>\$ 1 709</u>	

FIG 6 Excess Capacity Costs Excluded from Normal Burden Rate

Required economical use is the number of hours per week each machine must operate to justify its use. In determining this, alternative methods of doing the same work are considered. Costs for any activity should not exceed those experienced in any alternative method.

The column headed normal use contains the number of hours per week each machine operates to meet average commercial demands, as determined from past experience and a forecast of future trends based on market surveys.

In this case excess capacity in hours per week is the amount by which the required economical use exceeds the peak demand. Using group 1 machines only, the computation of excess plant expense, its exclusion from total overhead allocated to this group of machines to determine normal overhead and the establishment of the normal machine hour rate, is shown in Fig 6. The normal machine hour rate is stated as \$40 for fixed charges, (actually  $\$20.84 - 54 = \$386$ ). This plus variable costs of \$709 (i.e.,  $\$604 + \$675$ ) gives a normal machine hour rate of \$1169. Adding in the rate for direct labor, there results a standard processing cost per hour.

Compare the normal rate thus obtained with the rate based on normal capacity determined by ability to produce only. Assuming that practical capacity is 75% of the theoretical maximum, the normal rate for fixed costs is \$34.74 total expense, divided by 90 hours (75% of 120 hours). This yields \$386 per hour which is identical with the correct figure obtained on a sales expectancy basis excluding excess capacity. If normal is taken as 80% of theoretical maximum, the rate is \$362.

#### NORMAL CAPACITY ON DEPARTMENTAL BASIS—

Where departmental burden rates are used, it is necessary to determine the normal capacity for each department in the plant. In general there are two possibilities:

1. Set normal capacity for each department without regard to its relation to other departments in the plant.
2. Set the normal capacity of the "bottleneck" department, and relate all other departments to that normal. Under the latter approach additional excess capacity costs are created in other departments. These are sometimes spread over the estimated production. It is preferable to segregate and exclude them from normal rates. The problem is complicated further by the presence or absence of a market for partly processed goods.

Three-year tests in one factory disclosed that at full time operation actual output averages 80% of rated output. It would seem therefore, that practical capacity would be 80% of "bottleneck" operation.

**NORMAL CAPACITY AND NATIONAL DEFENSE—**Downie (N.A.C.A. Year Book, 1940) expresses the relationship between normal capacity and defense work as follows:

It seems to me that your basis for figuring your normal capacity for burden purposes would not change due to the acceptance or rejection of war order business. Your regular commercial business should be established normally for a long period of time. I am speaking here of course of the normal capacity for burden rate purposes. For the commercial business we have to establish these rates for a substantial period of years. If we have some excess capacity which is available for war order business it is assumed that the cost of maintaining that excess capacity has already been divorced from the burden rates for your normal commercial business,



and if that is the case then the war order business would not have any effect.

I should not think that it should have any effect at least on the burden rates to be used for the establishing of selling prices in your regular commercial business. Undoubtedly, so far as the government is concerned we will have to lower the total overhead rate for the entire plant and give effect to the reduced rate for the war order business. I think we will be called upon to do that. I think industry should be very careful not to disturb an established procedure in the price structure due to the acceptance of war orders. If we do we will be lowering our price levels to a point where, when the war orders cease we may find it rather difficult to bring those price levels back to a profitable range again.

Your normal capacity after taking into consideration your ability to market your merchandise and collect the money for it gives you the volume of business your factory can be expected to produce. Then you must determine how many hours of labor that volume requires for your factory. If it requires one shift, then it seems to me that your normal capacity should be considered one shift and burden rates should be established accordingly, unless you find it possible to go out and get additional business to run a second or third shift at which time I think the situation should be reviewed and adjustments made.

## Normal Burden Rates

**GENERAL FORMULA**—The generalized formula for computing a normal rate is

$$\frac{\text{Budgeted overhead at normal capacity}}{\text{Normal production}} = \text{Normal burden rate}$$

Production may be expressed in terms of units of product, labor dollars or hours, or machine hours; rates may be blanket, departmental, or by cost centers. However, a clear cut distinction must be maintained between normal and an estimate of actual for the coming period. On occasion the term "normal" is used loosely. For example in the Manual of the Standard Cost System for Photo-Engravers, issued by the American Photo-Engravers Association the statement is made that the correct basis for determining normal costs is an average of the preceding twelve months. This seems to be nearer an estimate of actual expense for the coming period based on the previous year's experience. Normal rates are based on estimated expenses at a selected normal rate of activity. They are the result of careful analysis for a period of years. Usually they are related to a budget.

**NORMAL CAPACITY AND STANDARD COSTS**—The standard overhead cost per unit is determined by use of a normal rate for the application of overhead to production. The normal rate is the ratio between normal overhead and normal production at normal capacity. Hence, the terms normal rates and standard rates are often used interchangeably.

**GRAPH OF BURDEN ABSORPTION AT PRACTICAL CAPACITY**—Fig 7 shows graphically the amount of overhead applied to the product at varying rates of capacity. It is adapted from Schlatter (Advanced Cost Accounting).

The horizontal axis *SP* represents activity with normal capacity based on practical operating level at *P* (100%). The vertical axis *PP* represents overhead expense in dollars. The line *AK* marks the division between fixed and variable expense. Hence any vertical line drawn from *SP* to *AK* shows the amount of fixed expense e.g. the line *VI*.

The line *AF* represents budgeted variable expenses at varying rates of activity. Thus at *A* (0% activity) there are no variable expenses and at *F* (100% activity) the variable expenses amount to \$10,000. At any rate of activity a vertical line erected from the line *AK* to the line *AF* gives budgeted variable expense (line *ID* shows \$8,000 variable expense at 80% activity). Note that these vertical lines vary proportionately to the rate of activity i.e. line *ID* is 80% of line *KF* which gives the variable expense at 100% activity.

If burden absorption rates are computed on the basis of practical capacity (\$22,000 total overhead expense divided by production as measured at practical capacity) the lines drawn vertical to axis *SP* and extending between the lines *AP* and *AF* represent the amount of overhead applied to the product at any rate of activity. Thus the line *MO* at 50% of practical capacity shows *MI* (\$6,000) of fixed expense absorbed and *IO* (\$5,000) of variable expense absorbed. Assuming that actual overhead for a given period was \$18,000 (line *UC*) when activity was at 50% of capacity, this is unabsorbed burden represented by *OO* (\$1,000) and *UM* (\$6,000). The line *CC* gives the amount by which actual overhead expense exceeded the budgeted amount and the line *UM* gives the amount of fixed expense which is unabsorbed due to below normal activity.

In general the line *AP* constitutes the dividing line between fixed costs that are absorbed by the normal burden rate, and fixed costs that are unabsorbed.

**BURDEN ABSORPTION AT NORMAL SALES EXPECTANCY**—If normal capacity based on sales expectancy is to be used as a base for calculating a normal burden rate, the amount of fixed overhead applied to the product at varying rates of activity is represented by the line *AY* (Fig. 7). This assumes that the expected rate of operations for the specified period is 80% of practical capacity. (In this case the normal burden rate obtained by dividing \$20,000 the total overhead expense represented by the distance *VD*, by the production as measured at the 80% level.)

The total amount of overhead applied to product is represented by lines drawn vertical to the axis *SP* and extending between the lines *AY* and *AF*. Thus, the line *RC* (at the point of 50% of practical capacity) shows *RH* (\$7,500) of fixed expense absorbed and *IC* (\$5,000) of variable expense absorbed. Two points are significant:

- 1 The same amount of variable expense is absorbed no matter which base is used for determining the normal (line *HO* at 50% activity).
- 2 Hence the comparative effect of the two bases (practical operation vs sales expectancy) is felt in the amount of fixed expense absorbed. When capacity based on practical operating level is used the fixed expense absorbed amounts to *MH* when capacity based on sales expectancy is used *RH*.

In general, the vertical difference between the lines *AP* and *AY* shows the difference between the two bases from the viewpoint of the application of fixed expense to the product. Point *P* represents the practical capacity of the department or plant expressed as an average, however, if burden rates are set on the basis of point *V* (sales expect-

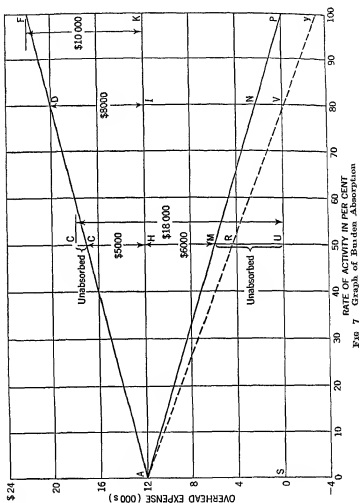


Fig 7 Graph of Burden Absorption

ancy equals 8% activity, due to inadequate demand for product), they have the effect of applying to the product some of the fixed cost allocable to unused capacity. On this point, Schlatter (N A C A Bulletin, vol 17) states

When average capacity (based on sales expectancy) is taken as the basis for a burden rate it is usually done with the idea that over a period of years production will so fluctuate below and above the base that unearned burden of some years will be offset by overabsorbed burden in other years thus leaving no burden balance and thus charging all fixed expense of both used and idle capacity to production. This rate always charges to the cost of goods some fixed expense not incurred in the production of the goods but incurred upon idle equipment. This practice cannot be defended with any logical argument. The usual defense offered for the use of this rate is "practicality" but I can see nothing "practical" in hiding the fixed expense of carrying idle equipment by showing it as a cost of goods produced without any use of this equipment.

As far as the absorption of fixed expense is concerned the use of the rate based on practical capacity is the only one that can be supported by logic. It charges the product with the fixed expense of only the capacity used, and leaves the losses due to unused capacity to be recognized for what they really are. It does not overstate the costs of the goods made in order to understate the unearned cost of carrying idle capacity. That expenditures made to carry idle equipment are cost I do not deny. But I do contend that the costs of capacity not used cannot logically be cost of goods produced in the used capacity.

#### METHODS USED TO APPLY NORMAL OVERHEAD —

The methods most frequently used to apply normal overhead in a standard cost system are

- 1 Standard Direct Labor Dollar
- 2 Standard Direct Labor Hour
- 3 Standard Machine Hour

Other methods may be used, such as a standard unit of product basis. Also a standard overhead rate may be combined with a standard rate for direct labor to obtain a standard productive hour rate, i.e., an inclusive rate for each cost center for direct labor and overhead.

A majority of the companies using normal rates employ standard direct labor hours as a major base, followed in importance by standard machine hours. In the latter case however a majority of companies use it as a secondary base. Direct labor cost is seldom used as a base for normal rates. The method of computing the rate for applying overhead on a normal basis and under each of the methods listed may be shown concisely by means of formulas

- 1 
$$\frac{\text{Overhead at normal capacity}}{\text{Standard amount of direct labor cost}} = \text{Standard percentage of direct labor cost}$$
- 2 
$$\frac{\text{Overhead at normal capacity}}{\text{Standard number of direct labor hours}} = \text{Standard overhead per direct labor hour}$$
- 3 
$$\frac{\text{Overhead at normal capacity}}{\text{Standard number of machine hours}} = \text{Standard overhead per machine hour}$$

Separate rates are calculated for each cost center, or department. If the plant as a whole constitutes a cost center, blanket rates are acceptable.

**Standard Direct Labor Dollar Method**—Objection has been expressed to the use of the direct labor dollar method. However, if labor rates at standard are uniform within a cost center or department, there remains no practical difference between this method and the direct labor hour method. Labor dollars are in the same ratio as labor hours, at standard.

A large manufacturer of an appliance forming part of an assembly in an automobile uses the standard direct labor dollar for applying normal burden to the product. Fig 8 illustrates the computation of a standard rate from the budget of overhead expenses at normal capacity. The burden percentage (451%) is obtained by dividing the normal overhead, direct and apportioned (\$183 019), by the standard direct labor dollars (\$40 320).

#### BUDGET AT NORMAL CAPACITY

Department—Cone Automatics (2 machines per operator)	YEAR _____		
	Fixed	Variable	Total
<b>Direct Charges per Annum at Standard Volume</b>			
Indirect labor	\$ 5 424	\$ 21 586	\$ 26 990
Supplies	none	3 809	3 809
Tools	none	23 306	23 306
Power	3 396	5 855	9 251
Maintenance	396	10 808	11 094
Losses—product scrapped, repairing defective product, waiting for tools waiting for materials	none	0 028	0 028
Property insurance taxes depreciation	32 073	none	32 073
<b>Total direct charges</b>	<b>\$41 714</b>	<b>\$ 77 216</b>	<b>\$118 930</b>
<b>Assessed Charges per Annum at Standard Volume</b>			
Utilities—boiler plant, service water, compressed air, heating system, butane gas plant, solution lines	\$ 360	\$ 808	\$ 1 168
General building expense—fire department, safety department, general maintenance laborers	6 106	9 187	15 293
General tool expense—toolroom, apprentice school, tool planning	3 844	6 932	10 776
General maintenance expense—machine shop, maintenance department	578	1 120	1 698
General burden—factory manager's staff, material control department, machine and tool development, labor standards, factory accounting, purchasing	17 100	17 094	34 194
<b>Total assessed charges</b>	<b>\$28 048</b>	<b>\$ 36 041</b>	<b>\$ 64 089</b>
<b>Total Charges per Annum at Standard Volume</b>	<b>\$69 762</b>	<b>\$113 257</b>	<b>\$183 019</b>
<b>Standard productive labor dollars per annum</b>	<b>\$40 320</b>	<b>\$ 40 320</b>	<b>\$ 40 320</b>
<b>Standard burden per cent per dollar of productive labor</b>	<b>173%</b>	<b>281%</b>	<b>454%</b>

FIG 8 Normal Direct Labor Cost Rates

All operations have standard times set for their performance. From these times at standard rates of pay, the standard labor cost is obtained. The latter multiplied by the normal overhead percentage gives the amount costed to product. Fig 9 shows a cost card for a "race." The first operation, cut-off is performed on cone automatics. The overhead



for this operation is applied at the rate of 454%, as indicated. Other operations are costed in a similar way (for overhead), from rates established from budgets at normal capacity.

**STANDARD DIRECT LABOR HOUR METHOD**—The standard direct labor hour method may be illustrated through its use in the bottling department of a brewery. Spitznagel (N.A.C.A. Bulletin, vol. 20) explains its use. In this case the demand justified operation at full capacity, i.e., 50,000 barrels per year. It was estimated that it requires 12 men an average of 40 hours per week, or a normal operating level of 2,080 hours per month. Flexible budgets were established.

Fig. 10 shows budget for bottling (covering direct departmental charges only). A separate flexible budget is established for general overhead and such overhead expense at normal was redistributed to each producing department. In this case it was found that 40% of the general budget at normal amounting to \$1,664 was allocated to the bottling department.

The standard direct labor hour rate for the bottling department is obtained as follows:

$$\frac{\text{Normal direct overhead}}{\text{Standard direct labor hours}} + \frac{\text{Allocated general overhead}}{\text{Standard direct labor hours}} \\ = \text{Standard rate per direct labor hour} \\ \frac{\$3,120}{2,080 \text{ hours}} + \frac{\$1,664}{2,080 \text{ hours}} = \$2.30 \text{ per standard hour of direct labor}$$

On flexible budgets the normal overhead is the total amount of the 100% column. It should not be assumed that the direct labor hour method is correct for all bottling operations. In some cases machine time is a better method, in others, unit of product (per case) proves adequate.

**STANDARD MACHINE HOUR METHOD**—Standard machine hour rates find an application in the fabric dyeing and printing industry. Then computation and use in determining unit costs are illustrated in Fig. 11. Sawyer (N.A.C.A. Bulletin, vol. 14) explains its use. The number of machines in each process multiplied by the plant operating time per day and modified by a standard operating percent gives the normal operating machine hours for each process. Thus for Singe,  $2 \times 10 \text{ hours} \times 75\% = 15 \text{ hours normal per day}$ . The normal overhead budgeted per day divided by the normal operating hours gives the standard machine hour rate for the process. For Singe,  $\$30.75 \text{ normal budget per day} \div 15 \text{ hours, normal operating time,} = \$2.05 \text{ per standard machine hour}$ . This machine hour rate divided by the standard operating speed yields the standard cost per 1,000 yards for overhead. For Singe,  $(\$2.05 \div 4,000) \times 1,000 \text{ yards} = \$51.25 \text{ overhead product cost per 1,000 yards}$ . Use of such standard machine hour rates makes it easy to compensate for varying rates of machine speed on different classes of product. Note for example the process, White Tenter.

**STANDARD PRODUCTIVE HOUR METHOD**—Restell (N.A.C.A. Year Book 1931) has defined a standard productive hour as "the standard amount of product that is to be turned out in an hour at every operating or cost center of the plant." Under this method the standard rate for overhead per hour in each cost center is combined with a stand-

## MONTHLY BUDGET OF DIRECT OVERHEAD EXPENSES

BOTTLING DEPARTMENT		NORMAL CAPACITY 20 800 cases 2 080 hours						
Expense Items		80%	85%	90%	95%	100%	105%	110%
Supervision	b							
Indirect Labor								
Crowns Labels etc								
Supplies and Expenses Miscellaneous								
Water Light and Power								
Repairs to Machinery								
Repairs to Buildings								
Depreciation of Machinery and Tools								
Depreciation of Buildings								
Insurance								
Taxes, Property								
		\$2 514 00	\$2 642 00	\$2 863 00	\$2 990 00	\$3 120 00	\$3 256 00	\$ 3 392 00

FIG 10 Monthly Budget of Direct Overhead Expenses



PLANT OPERATING TIME 10 hours

Process	Machines	Standard		Budget per Day	Machine Rates		Class	Speed	Standards (Per M Yards)	
		Per Cent	Hours		Burden	Labor			Burden	Labor
Grey Storage	2		10	\$ 74 36	\$7 440	\$ 30	All	30 000	\$ 2 480	\$ 075
Singe	15	75	15	30 75	2 050	10		4 000	.5125	
Bleach Kiers	10	150	100	275 20	1 840	04				
Bleach Open	30	150	430	127 33	2 283	43		4 800	5290	090
White Driers	4	95	38	98 52	2 540	37	1	1 500	1 3333	240
White Tentor	1	75	7 5	15 00	2 000		2	1 000	2 0000	370
White Winders	2	60	6	3 36	560	24	3	500	4 0000	740
Printing	8	95	76	601 92	7 920	2 38	W	3 000	1867	080

FIG 11 Calculation of Cost Standards

and rate per hour for direct labor, to obtain a standard operating cost rate. Thus, an inclusive cost rate is obtained for each cost center which may be applied to all products on which work is performed. Standard times are used and standard unit costs result.

To compute a standard operating cost rate the budgeted overhead at normal the productive output in hours at normal capacity, standard times of operations and standard labor rates are essential elements. The following computation illustrates this method of setting a standard operating cost rate for cost center C 1 which does pipe cutting.

Direct charges at normal	\$4 200
Apportioned charges at normal	2 600
Total overhead at normal	<u>\$6 800</u>
Normal capacity in standard hours	<u>3 600</u>
Normal overhead rate per standard hour	\$1 90
Standard labor rate per hour	65
Standard operating cost rate, per hour	<u>\$2 55</u>

**Normal Rates per "B"**—Peden in an article on Accounting with the Point System (N A C A Bulletin, vol 12), describes an extension of the Bedaux point wage payment plan to its use for the application of burden. Essentially the same method is involved as in the case of the standard productive hour. The difference lies in the use of a standard minute of productive work for purposes of computation, instead of a standard hour of productive work.

A "B" represents one minute of work, including a proper allowance for rest. "B" values are set on the basis of accurate time study, and in an operation such as hammer forming, tables are established by which proper compensation can be made for weight of slugs and number of hits per slug. From data so obtained, the normal number of "B's" per machine hour are determined. For the company in question these contained a process allowance (P A). The calculation of normal burden rates per "B" is shown in Fig 12. With direct labor included, an inclusive cost at standard for each detailed operation is readily determined. Fig 13 presents a cost sheet showing use of "B" values in determining product costs. The number of "B's" in each operation times the number of pieces gives the total number of "B's", this multiplied by the standard rate per "B" yields the operation cost for labor and overhead.

**UNIT OF PRODUCT BASIS**—The computation of normal rates based on units of product is easily effected. The formula is

$$\frac{\text{Normal overhead}}{\text{Normal output}} = \text{Rate per unit}$$

The development of the normal cost per unit of production in the hosiery field is illustrated by McCullaugh (Full Fashioned Hosiery Industry). Rates per dozen are used in three departments, namely, grey goods stock dyeing, and finished stock. Rates are determined

1 By finding the normal production per month in each department. In actual practice if the mill is operating under normal conditions the normal production should be taken as the actual expected output for the succeeding six months. If however the mill is operating below normal from 75% to 85% of capacity is generally taken as normal.

CALCULATION OF COST RATES PER HOUR AND PER B

Machine Center	Annual Burden Based Upon Normal Operations	Annual Machine Hours Based Upon Normal Operations	Normal Burden or Cost Rates per Hour (Including Direct Labor)	Average Number of Direct Bs (Plus P. A.) Produced by Each Center per Machine Hour	Normal Burden or Cost Rates per B (Including Direct Labor and All Fixed and Variable Charges)
6 Hammers 2500 #	\$ 54 920	14 850	\$3 698	65	\$ 04689
5 Hammers 1500 #	35 962	12 375	2 906	65	04471
2 Hammers 1000 #	14 943	4 900	3 019	65	04645
1 Press Coning	12 167	2 475	4 916	140	03511
1 Press Toledo	13 214	2 475	5 339	140	03814
1 Press Cleveland	12 022	2 475	4 898	140	03499
1 Press Bliss D A	11 756	2 475	4 749	140	03392
1 Press Bliss S A	32 289	7 425	4 349	140	03106
1 Header	20 408	4 676	4 364	140	03117
Trimming Press B S & Ch	5 365	2 475	2 168	70	03097
Trimming Press Toledo #3 1/2	42 529	27 225	1 562	70	02231
Trimming Press Toledo #5 A	8 708	4 950	1 759	70	02513
Large Shear	4 855	2 475	1 962	65	03018
Small Shear	4 897	2 475	1 979	65	03045
Band Saws	30 798	15 525	1 984	70	02834
Grinders	12 335	7 425	1 661	70	02373
Bench Work	3 880	2 750	1 411	70	02016
Tinning	4 573	1 375	3 326	70	04751
	\$325 621				

Note These figures are illustrative

Fig 12 Normal Rates per B

## COST SHEET

COMMODITY		Hammer Forging		Part No F 4293		Prod Order No 8000	
CUSTOMER S NAME		Blank Electric Corporation		Sales Order No 50872		Date Completed 8/25/—	
Description of Part—Forged Elbow		Kind of Material—12300# 29/32" Round Ext Only Rod Mixture No 211		Quantity Ordered 10 000		Quan Completed 17 000	
	Weight per C	Total Material Used (Lbs )	Cost per Lb	Cost per C	Depart- ment Cost	Total Cost	
Cold Metal	61 005	12 009	\$ 0818	\$5 064	\$82 34	\$ 883 38	
Forging Scrap		3 137	0800		98 96		
Net Metal		10 762	0150		100 94		150 00*
Casting Shop Conv		12 009					
Rod Mill Conc							
Forging Shop Conv				1 855		240 99	
Total				7 019		1 224 37	
Total Metal and Conv				803		82 00	
Tool Costs				7 321		1 277 03	
Factory Cost				488		85 25	
Selling and Administrative 25% Conversion (Do not include tools)				7 899		1 862 28	
Selling Cost				8 500		1 482 74	
Selling Price							
Purchased Parts							
Note These figures are illustrative.							
* Forge or Sand Foundry Operations		Pieces Produced	Number of Men	B Value	Total Bs	Cost per B	Total Cost
Set Up	3 times	1	1	\$ 90	270	\$ 0569	\$ 12 36
Shear	15 081	1	1	0272	492	0300	15 01
Forge	17 809	1	1	0905	1 700	0569	96 73
Trim	17 444	1	1	0590	1 029	0223	22 95
Total							\$150 00

Fig 13 Applying Normal B Rates to Product

	Departmental Details		Summary of Cost	
	Amount	Per N T	Amount	Per N T
<b>Pattern Department</b>				
Direct Charges				
Labor:				
Charged to Molding Department	1,830.00	1.88		
Charged to Core Department	630.00	.96		
Charged to Special Charges	590.00	.89		
Charged to Customers	750.00	1.14		
Total	3,800.00	4.88		
Supplies:				
Molding	180.00	.37		
Core	100.00	.16		
Special Charges	80.00	.12		
Charges to Customers	90.00	.14		
Total	450.00	.69		
Overhead				
Labor	620.00	.79		
Supplies	160.00	.23		
Supervision	300.00	.45		
Total	970.00	1.47		
Total Pattern Department	4,820.00	7.00		
Special Charges Other Than for Patterns				
Core				
Special Ripping				
Special Machining				
Total Special Charges Other Than for Patterns				
<b>W rks Burden</b>				
Steam, Power and Light	3,300.00	5.00		
Tax	1,320.00	2.00		
Safety, Casualty, W ifare and Pensions	650.00	1.00		
General Repairs	3,800.00	5.00		
Loss on Defectives (Back Charges Returned Castings)	3,684.00	5.60		
Insurance	1,980.00	3.00		
Taxes	680.00	1.00		
Depreciation	3,880.00	6.00		
Clerks' Salaries and Order Department	1,980.00	3.00		
Accounting Department	980.00	1.50		
Management Salaries	3,500.00	5.00		
Engineering Department	900.00	1.50		
Purchasing Department	688.00	1.25		
Inventory Adjustment	330.00	.50		
Miscellaneous Operating Expenses	5,168.00	8.00		
Total W rks Burden	30,827.00	46.86		
TOTAL EXCLUDING NET METALS			99,872.80	151.52
Total Works Cost			115,397.50	175.60
<b>Administrative and Selling Expenses</b>				
Administrative Expense	4,620.00	7.00		
S elling Expense	4,465.00	6.78		
Total Administrative & Selling Expense			9,075.00	13.78
Total Cost			124,472.50	189.38
Product of Metals Charged into Furnaces			Good Castings	
	Net Tons	% of Total		Net Tons
Good Castings (Yield)	660	66.0	On Hand 1st of Month	100
Scrap:			Produced during Month	400
Defective	44	3.7	Total	720
Slag	4	.3	Shipped during Month	600
Reeds and Gates	336	28.0	On Hand Last of Month	120
Other Recovered Metals	36	3.0		
Total Scrap	420	38.0		
Melting and Foundry Loss	120	10.0		
Total Charge	1,200	100.0		

FIG 14 Summary of Foundry

	Net Tons Charged	Price per Net Ton	Cost per Net Ton Charged	Departmental Details		Summary of Cost	
				Amount	Per Net Ton Good	Amount	Per Net Ton Good
<b>MELTED METALS</b>							
Pig Iron	120	\$5.00	2.50	600.00	4.55		
Purified Scrap	647	18.00	9.71	11,846.00	17.64		
Own scrap	416	13.00	4.49	5,398.00	8.17		
Fe Manganese	12	90.00	98	1,176.00	1.78		
Fe Silicon	2	70.00	38	468.00	.71		
Special Alloys							
Total Charge	1200		18.07	21,688.00	32.85		
Loss Scrap Recovered	420	13.00	4.55	5,460.00	8.27		
<b>Net Total</b>			13.52			16,228.00	24.58
<b>PRODUCTIVE AND SERVICE DEPARTMENTS</b>							
<b>Painting Department</b>							
Labor			4.20	5,040.00	7.84		
Fuel			3.80	4,560.00	7.54		
Power Mkt (A) per MWH							
Electrodes							
Supplies			1.02	1,224.00	1.85		
Furnace Repairs			80	1,080.00	1.64		
Other Repairs			40	480.00	.73		
<b>Total Painting</b>			10.12	12,144.00	18.40		
<b>Molding Department</b>							
Direct Labor				11,805.00	18.05		
Overhead Labor				7,860.00	11.90		
Sand				1,189.00	1.80		
Sand Mixture Ingredients				246.00	.38		
Fuel				864.00	1.30		
Supplies				684.00	1.40		
Flasks				330.00	.50		
Repairs				964.00	1.44		
Supervision				1,354.00	2.10		
<b>Total Molding Department</b>				24,560.00	37.24		
<b>Core Department</b>							
Direct Labor				3,300.00	5.00		
Overhead Labor				1,320.00	2.00		
Sand				464.00	.70		
Fuel				394.00	.60		
Supplies				990.00	1.50		
Repairs				415.00	.63		
Supervision				488.00	.74		
<b>Total Core Department</b>				7,961.00	11.83		
<b>Cleaning and Finishing Department</b>							
Direct Labor				6,600.00	10.00		
Overhead Labor				2,244.00	3.40		
Supplies				4,820.00	7.00		
Repairs				85.00	.13		
Supervision				650.00	1.00		
<b>Total Cleaning and Finishing Department</b>				14,949.00	22.45		
<b>Heat Treating</b>							
Labor				755.00	1.10		
Fuel and supplies				1,320.00	2.00		
Repairs				89.00	.15		
<b>Total Heat Treating</b>				2,144.00	3.25		
<b>Pattern Storage, Inspection, Shipping</b>							
Pattern Storage				50.00	.08		
Inspection				990.00	1.40		
Shipping				1,890.00	3.00		
<b>Total Pattern Storage Inspection &amp; Shipping</b>				5,440.00	8.25		

Direct Departmental Costs

	Depart- ment Summary	Works Burden	Share of Pattern Depart- ment Expense	Direct Labor	Adjusted Depart- ment Cost	Depart- mental Over- head Factors	Basis
Melted Metal	\$24 58				\$ 24 58		Yield
Metal Conversion	18 40	\$ 8 05			20 45		Yield
Mold	19 24*	16 29	\$ 3 88	\$18 00	57 41	219%	Direct labor
Core	6 53*	5 04	2 00	5 00	18 57	271%	Direct labor
Cleaning and Finishing Depart- ments	12 65*	9 91		10 00	32 56	226%	Direct labor
Service	8 25	3 60			11 85	11 85	Per ton of good castings
Pattern Department	7 00	3 06	(10 06)†				
Special Charges			1 85		1 85		
Charged to Customers			2 33		2 33		
Total Works Cost	\$96 65	\$45 95		\$33 00	\$175 60		Works cost
Administrative and Selling					13 75	7 8%	
Total					<u>\$189 35</u>		

\* Exclusive of direct labor

† ( ) = red figures

Fig 15 Recapitulation of Works Cost by Departments including Redistributed Service Charges

2 By calculating the fair and proper amount of labor and expense which should be spent monthly by each department for each classification in order to produce the predetermined output. In reality, this is equivalent to setting a complete budget for each operating unit.

3 By carrying out the same method of distribution and calculation of direct labor and expense rates per unit of production as would be followed for the actual cost within any one month. The work of budgeting labor and expense and the predetermination of normal production should receive the careful consideration of the chief executives of the company, in order that the normal shall be thoroughly approved before being used.

Customer _____				Pattern No. _____	
Address _____				Drawing No. _____	
Name of Casting _____				Date _____	
PRODUCTION				DETAILS OF COST	
Description	Pcs	Piece Weight	Total Weight	Per N T	Per Piece
Order	12		3600		4.50
Defective (B)	2	200	400		1.60
Good (A)	10	300	3000		1.20
4 Def. of Good			200		40
Shipped Weight					
PRODUCT OF CHARGE					
Base Iron		Weight	P. cent		
Good		4000	4.2		
Defective		200	9.6		
Slag		16	1.3		
Heads, Gates, etc.		1000	15.9		
Other Metals Rec'd		167	3.0		
1 Mol. Scrap		2000	4.3		
Wt. & Wdg. Loss		825	10.0		
Total Charge		8228	100.0		
FEES, DUES FOR GOOD CASTINGS					
Registration		Weight			
Head		80			
Gate		20			
Risers		80			
Total per Mold		180			
Total per On Sing		180			
PATTERN EQUIPMENT					
No. of Patterns					
Kind of Pattern		Wood			
Molding Method		Hand Rammed			
Size of Class		4"x5"x20"x16"			
No. of Patterns in Class		1			
No. of Res. per On Sing		6			
No. of Castings x P. Mold		1			
DETAILS OF COST					
Melted Metals Conversion					
Direct Labor					
Moldings					
Molders					1.60
Apprentice					1.20
Dry Floor Molder					40
Dry Fl. P. Molders					-
Barcative Casting 20% of above					.84
Contingency 5% of above					.19
Total Molding Direct Labor				28.87	4.25
Gases					
Coremakers					.80
Apprentice					-
Molders					-
Defective Castings 20% of above					.19
Dry Break & C. at 10% of above					.27
Tot. 1 C. per M. & Lab.				8.17	1.22
Cleaning and Finishing					
Flanging					.20
Removing heads and gates					.80
Chipping					.45
Grinding					.18
Straightening					.16
Cleaning Defective					-
Gating 10% of labor					.13
Total Cleaning M. & Lab.				9.80	1.38
Overhead					
Welding				214	8.25
Dry				271	2.14
Cleaning & Finishing				229	8.11
Heat Treat, Patt., etc.				11.85	1.78
Net Metals				28.82	3.25
Special Alloy					
Total Works Cost				203.52	30.35
Special On. & e					
On. & Lab. Charge & Overhead					
Total					
Administrative & Selling -					
(7.0% of Total)				14.27	2.38
Returns & Allowance					-
Machining & Other Risks					-
Total Cost F. & B. Foundry				219.30	32.61
SUMMARY OF PROFIT & LOSS					
	Per N T	Per P.			
Gross Selling Price	280.00	27.00			
St. & Lab. Charges					
Freight	7.42	1.12			
Other					
Net Selling Price	244.54	25.88			
Total Cost	219.30	32.61			
Profit and Loss	25.15	5.47			

FIG 16 Cost Record for Individual Castings Actual or Estimated



Normals should ordinarily be revised or reviewed at the end of each six months period

### USE OF DIFFERENT NORMAL RATES IN SAME PLANT

—Where departmental rates are set, different bases are often found in the various departments. Thus the Manual of the Steel Founders' Society of America (Job Cost Finding Practice) shows in detail the computation and application of normal departmental rates. A summary of monthly or normal costs of production in total and per net good ton of castings is shown in Fig 14. Fig 15 is a recapitulation by productive departments. It indicates distribution of works burden and pattern expense, and shows the determination of departmental overhead rates.

In Fig 16 is presented a cost record for an individual order, showing the application of burden rates. For example, direct departmental charges for molding amount to \$37.24 per net ton of good casting (Fig 14). When apportioned charges for works burden and pattern expense are added, it is found that total molding department expense is \$57.41 per net ton of good casting (Fig 15). This total divided by the direct labor cost (\$18) gives an overhead rate of 319% of direct labor (Fig 15). On the individual cost card (Fig 16) this rate is applied to the total direct labor cost for molding to obtain overhead cost (\$4.03 direct labor cost for molding  $\times$  219% gives \$8.83 overhead cost for molding, per net ton of good casting on the job).

### SEPARATE RATES FOR FIXED AND VARIABLE OVERHEAD

—Frequently, it is advantageous to obtain separate rates for fixed and variable overhead. Two points are involved:

- 1 Segregation of fixed charges including stand-by portion of semi-variable items
- 2 Distribution of fixed and variable charges

**Segregation of Fixed Charges**—This point is illustrated by Patterson, in connection with a discussion of power costs (N. A. C. A. Bulletin, vol. 16).

From past experience it is known that the following consumption of power (including line loss) will be required for the production selected:

Commodity	Production Units (Normal Sales)	Kwh
A	1 000 000	15 000
B	1 000 000	30 000
C	350 000	90 000
Mechanical Shops		5 000
Steam Plant		1 000
General Factory		4 000
Total kwh required		145 000
Cost per kwh		\$ .03
Total purchased power		\$4 350.00
Electric light		200.00
Total		<u>\$4 550.00</u>

Included in the above rate of \$ .03 per kwh is the demand charge totaling \$500 per year. The demand charge and the current used for lighting

are considered fixed therefore, the total purchased power and light is separated into \$700 fixed and \$3 850 variable.

The only power equipment belonging to the company is a transformer meter and service lines the maintenance of which does not vary with production and is therefore fixed expense. The estimated costs of Service Department I Purchased Power and the distribution of the total fixed and variable costs to commodities and operations on the basis of the estimated kwh applicable to each, is shown below.

ESTIMATED COSTS SERVICE DEPARTMENT  
PURCHASED POWER

Service	Totals per Year	
	Fixed	Variable
03-Indirect labor—maintenance	\$ 30	
13-Maintenance materials	40	
20-Purchased power and light	700	\$3 850
19-Depreciation	10	3
Totals	<u>\$785</u>	<u>\$3 853</u>

Regarding the same point Schlatter, in an article on Distributing and Controlling Overhead (N A C A Bulletin, vol 17), says

For years I have seen service department expenses such as power expense for example, distributed in the ratios of actual consumption of service that is, if one department consumed twice as much service as another, it is charged with twice as much service expense as is charged to the other. In my opinion this method is many times incorrect. It can be correct only when all consuming departments consume service in a constant ratio, that is if the departments always consume in the same relative ratios as their capacities to consume. For example, let us assume that at normal Department A consumes twice as much service as Department B. If the consumption ratios are still 2 to 1 with operations at 80% 60% or any other per cent of its normal, then the consumption ratio method of apportioning the service expense gets correct results.

But, if the activities of A and B vary from their normal ratios in any period the distribution on the actual consumption ratios produces weird and incorrect results. For example if the normal consumption ratios are 2 to 1, and the actual consumption ratios are 1 to 2 A if given but one third, would be charged with too little and B if given two thirds would be charged with too much of the service expense.

Fixed expense may be considered a capacity expense, while variable expense is an activity expense. That is fixed expense of any service department is dependent, at any given moment, on its capacity to serve, but this capacity to serve is related to the capacities of producing departments to operate. Therefore, the fixed expense of service departments should be distributed in the ratio of capacities not according to the rate of operation. On the other hand, variable expenses are occasioned by the extent to which activity occurs, thus becomes the basis on which such expenses should be distributed. The point is illustrated in the case of power distribution by Schlatter (cited above).

This illustration assumes that the power plant has just sufficient capacity to supply power to the two consuming departments when both are working at their full capacities. Power consumptions at full practical capacities are assumed to be 15 000 units and 10 000 units for Departments I and II respectively. When the departments are working at less than capacities and not in capacity ratios the following distributions result:

## Consumption of Power

	Units	Power Expenses	
Department I	12 000	Fixed Expense	\$5,000
Department II	4 000	Variable Expense	1 000
Total	<u>16 000</u>	Total	<u>\$6 000</u>

## DISTRIBUTIONS

## A On the single base method (Consumption ratios)

Burden Department I (12/16 of \$6 000)	\$4 950
Burden Department II (4/16 of \$6,000)	<u>1 050</u>
Power Expense	\$6,000

## B On the double base method

## 1 Fixed Expenses (Capacity ratios)

Burden Department I (15/25 of \$5 000)	\$3 000
Burden Department II (10/25 of \$5 000)	<u>2 000</u>
Power Expense	\$5 000

## 2 Variable Expenses (Consumption ratios)

Burden Department I (12/16 of \$1 600)	\$1 200
Burden Department II (4/16 of \$1 600)	<u>400</u>
Power Expense	<u>\$1 600</u>
	<u>\$6 600</u>

In this case the two methods get decidedly different results. The single base method charges Department I with \$750 more and Department II with \$750 less than the double base method charges. The single base makes Department I pay a penalty for the greater idle time in Department II.

## Application of Separate Rates for Fixed and Variable Overhead

—Fitch, in discussing the distribution of manufacturing expenses (N.A. C.A. Bulletin, vol. 22), illustrates the computation and application of double rates for overhead.

The company believes that possession of such knowledge as it has acquires in no small degree for the fact that only in one year during the depression did it sustain a net loss and that of such small proportions that working capital was scarcely affected.

Flexible budgets are constructed for each department. The budget for Department 3 is presented in Fig. 17. These budgets are used for control purposes, from them overhead rates are computed. Group 1 expenses include departmental direct charges over which factory manager can exercise control. Group 2 expenses are those subject to relatively little, if any, control by the factory manager. Normal capacity for Department 3 has been set at a point of "normal utilization," or at 66⅔% of practical capacity. Each budget contains a list of expenses under temporary shutdown conditions. For Department 3 (Fig. 17) these amount to \$19,150 per annum. Then the direct labor dollar rate at standard for fixed overhead in Department 3 is 85%, found by dividing stand-by expenses of \$19,150 by \$22,400, the standard labor at normal utilization.



STANDARD COST SHEET									
Date <u>12/1/-</u>		Revised <u>✓</u>				Style <u>304 G M</u>			
Fin Yds <u>30.000</u>		Fin width <u>1/2</u>		Fin weight <u>2.4 oz</u>		Est'd Shrinkage <u>1/2</u>			
STD COST PER UNIT	MATERIALS			POUNDS	UNIT PRICE		EXTENSION		TOTALS
	Sisal								
	Gunny								
	Bogging								
	Hair								
	S riap								
	Total Lbs			265.230					7 956 00
	Direct Supplies (Detail on other sheet)								
	1 231 60								
	9 188 50								
	TOTAL COST OF MATERIALS								
	DIRECT LABOR AND MANUFACTURING EXPENSES								
				DIRECT LABOR		APPLIED MANUFACTURING EXPENSE			
						VARIABLE		FIXED	
	DEPARTMENT	COST	HOURS	RATE	AMOUNT	RATE	AMOUNT		
	1	541 63		141%	763 70	49%	265 40		
		214 67		79%	169 59	31%	66 55		
	3	530 25		160%	2 462 80	85%	1 08 36		
	4	827 48		102%	844 02	38%	14 44		
	5	675 35		96%	646 40	44%	295 27		
	6a	417 89		99%	413 71	21%	87 76		
				003%		0007%			
	10			1%	928 30	1%	185 66		
	Totals	4 214 25			6 228 52	2	24 44	4 214 25	
	TOTAL COST OF DIRECT LABOR								
	TOTAL PROVISION FOR MANUFACTURING EXPENSES								
	Variable Expenses								
	Fixed Expenses								
	6 228 52								
	2 524 44								
	8 752 96								
	TOTAL COST OF MANUFACTURING								
	32 155 71								
	SELLING AND GENERAL EXPENSES								
	Variable Expenses								
	Fixed Expenses								
	TOTAL COST DELIVERED								
	PROFIT MARGIN								
	SELLING PRICE (STANDARD)								

Fig 18 Cost Sheet for Separate Application of Fixed and Variable Charges

Also, variable expenses at normal utilization (66%) divided by standard labor dollars gives rate for variable overhead

$$\frac{\$54,680 - \$10,150}{\$22,400} = 100\%, \text{ rate per direct labor dollar at standard, for variable overhead Department 3}$$

The over all rate for applying normal overhead, Department 3 is the sum of these two rates, or 245%. In same way, the rates for all producing departments are obtained.

Fig 18 presents a standard cost sheet used by this company. Note that provision is made thereon for an individual record of variable and fixed costs of each department, also, a summary of the total of each component.

**Advantages of Separate Rates**—There are certain advantages in using separate rates, one for fixed and one for variable overhead.

1 Differential costs are more readily determinable from all standard cost cards.

2 Division between fixed and variable cost is carried forward into all unit cost computations which is of advantage to the sales division in making bids, particularly where volume considerations are involved.

3 It aids in making cost adjustments from year to year. Note in Fig 17 that the variable cost rate is constant no matter what the rate of activity. Once these rates have become set, after a year or two of experience they take on the character of a basic standard and are not subject to change until or unless some major change in technology or organization occurs.

4 Double rates permit easy shifting of unit costs from a standard basis to a current budget basis. Variable unit costs are the same for any level of activity; it is fixed burden which is affected by fluctuations in volume. For example, the rate of application for fixed overhead for Department 3 was computed on the basis of a normal utilization of 86% (Fig 17). Assuming that the current budget is for 50% of practical operating capacity in Department 3 there are two ways of computing the fixed overhead to be posted to cost sheet (Fig 18).

- a Recompute the fixed overhead rate on the basis of normal utilization of 50%

$$\frac{\$19,150}{\$16,800} = 114\%$$

The amount chargeable to the job then is

$$\$1,539.25 \times 114\% = \underline{\underline{\$1,754.74}}$$

- b Convert the amount already costed to the new operating level

$$50\% - 86\% = 75$$

Hence, \$1,308.36 (the amount already charged) is divided by 75

$$\$1,308.36 \div 75 = \underline{\underline{\$1,744.48}}$$

(The difference between the two results is due entirely to rounding off of fixed expense percentages. Instead of 86% and 114% the exact rates are 85.491% and 113.989%.)

If all departmental normals are set at the same point relative to maximum capacity, one computation for total fixed expense applied suffices to convert the standard unit cost for fixed burden to any budget basis. The addition of variable costs per unit yields recomputed unit costs on the new budget basis.

Where two overhead rates, one for fixed and one for variable, are available, costs computed at practical capacity may be used for internal costing entries and to price inventories, while these same costs may be modified to the level of the current budget for sales policy purposes. Finally determination and use of fixed and variable rates for overhead is an integral part of departmental budgetary control procedure. Each

BUDGET REPORT - MONTHLY DEPARTMENT 3									
Month and 3 Months Period End ng <u>March 31, 19--</u>									
ACCOUNT	F	V	THIS MONTH			YEAR TO DATE			
			ACTUAL	BUDGET	ACTUAL U or IOI	ACTUAL	BUDGET	ACTUAL U or IOI	COMMENTS
Direct Labor	\$		\$2 195 70	\$1 890 00	\$1306 701	\$ 4 673 39	\$ 4 510 00	\$1 653 391	March 203 70 up to 19--
Foremen		16	\$ 300 00	\$ 296 00	\$1 4 001	\$ 762 47	\$ 722 00	\$1 40 471	Weekly rate
Helpers		36	749 36	666 00	1 85 361	1 703 11	1 624 00	1 75 111	Weekly rate
Supplies		29	501 29	537 00	1 5 71	1 370 30	1 308 00	1 62 301	Weekly rate
S. S. & Work Com		6	130 77	111 00	1 19 771	276 25	270 00	1 6 251	Weekly rate
Repairs - M & E	42 00	18	298 77	375 00	76 29	1 049 63	938 00	1 111 631	See from Report
Group 1	\$ 42 00	105%	\$1 980 13	\$1 985 00	\$ 4 87	\$ 5 161 76	\$ 4 862 00	\$1299 761	
Repairs -	\$	2	\$ 216 14	\$ 79 00	\$1137 141	\$ 279 30	\$ 216 00	\$1 63 301	OK - Seasonal
Building		22	475 17	503 00	27 83	1 502 33	1 280 00	1222 331	-
Electricity		-	225 00	225 00		1 575 00	675 00	675 00	normal
Taxes & Ins		-	820 00	525 00		1 575 00	1 575 00	2 050 00	
Depreciation		18	430 32	749 00	319 68	1 814 19	2 050 00	215 81	
Experimental	416 00	18	538 00	490 00	1 48 001	1 170 39	1 336 00	165 61	
General Factory	250 00	13							
Group 2	\$1 254 00	55	\$2 408 65	\$2 571 00	\$ 162 37	\$ 7 046 41	\$ 7 142 00	\$ 95 59	4/19 - 19--
	\$1 296 00	160%	\$4 388 76	\$4 556 00	\$ 167 241	\$12 208 17	\$12 004 00	\$1204 171	0 16
Burden Absorbed (\$1 850 00 x 245%)			\$4 532 90	Burden Expense (Actual)			\$12 208 17		
Burden Expense (Actual)			4 388 76	Burden Absorbed (14 510 00 x 245%)			11 049 50		
Burden Overabsorbed			\$ 144 74	Burden Underabsorbed			\$ 1 158 67		
Volume Variance (4532 90 - 45567)			- 23 50	Volume Variance			954 50		
Expenditure Variance (4556 - 4388 76)			+ 167 24	Expenditure			204 17		
			\$ 143 74				\$ 1 158 67		

Fig 19 Budget Report with Variance Analysis

day, the foreman has an accurate knowledge of his direct labor costs. This total, multiplied by his variable rate for overhead (for direct charges only) gives him information regarding what he should have spent for indirect charges. Daily expense control reports may be issued on this basis.

**DISPOSITION OF OVER OR UNDERABSORBED NORMAL OVERHEAD**—Where rates for the application of overhead to product are based on normal capacity, the differences between the amount of overhead absorbed and the actual overhead expense are analyzed for control purposes according to volume variance and controllable (or expenditure) variance. When normal rates are correctly set, under- or overabsorbed overhead is not caused by errors in determining the rates, but rather, to off-normal operating conditions. The budget report constitutes one method widely used to disclose the amount of under- or overabsorbed overhead. Fig. 19 shows a budget report, for the current month and cumulative to date, with differences between the actual overhead and amount absorbed analyzed according to volume variance and expenditure variance. (See Sections 2 and 7.)

A variety of practices exists regarding the disposition of under- and overabsorbed burden arising from the application of normal rates. The more important methods are

- 1 Adjust cost of sales
- 2 Write off to profit and loss
- 3 Adjustment of gross profit
- 4 Carry to a reserve account
- 5 Adjust cost of sales and inventories on a pro rata basis

**Cost of Sales Adjustment**—In some cases the cost of sales is adjusted at year end only, in others monthly. This method may also be combined with a write off to profit and loss (see below).

**Write Off to Profit and Loss**—Some companies handle underabsorbed burden in this way, but vary the procedure for overabsorbed burden. Also some concerns use the first method for controllable variance and the second for the volume variance. Van Sickle (*Cost Accounting*) shows a segregation of the two types in the operating statement. Fig. 20 illustrates a method of presentation when unabsorbed fixed overhead is recognized as idle capacity cost and is handled as a profit and loss charge, while under- and overabsorbed variable (or controllable) overhead is grouped with other standard cost variances as adjustments of the cost of sales. The same author, however, also shows over- and underabsorbed burden as secondary income and expense.

**Adjustment to Gross Profit**—The National Association of Furniture Manufacturers in its cost manual suggests deducting unabsorbed burden from gross profit. Otherwise there is little support for the idea either in theory or practice.

**Use of Reserve Account**—Basically, this means the offsetting of underabsorbed overhead in one year with overabsorbed overhead in another year. The idea is an extension to an entire business cycle of the principle applied to monthly variations in a seasonal business. It constitutes a logical disposition of volume variances which arise when a normal rate has been established on the basis of customer demand.



## STATEMENT OF PROFIT AND LOSS

JANUARY 1, 19\_\_ TO JANUARY 31 19\_\_

Sales			\$111 000 00
Cost of Goods Sold			
Finished goods inventory (standard) January 1		\$10 793 35	
Cost of production (standard), January 1 to January 31		84 172 38	
Cost of goods handled (standard)		\$94,965 73	
Finished goods inventory (standard) January 31		10 494 76	
Cost of goods sold (standard)		\$84 470 97	
Unfavorable cost variances			
Purchase price variance	\$ 892 11		
Material usage variance	43 00		
Labor rate variance	200 00		
Total unfavorable cost variances		\$1,235 11	
Favorable cost variances			
Labor time variance	\$148 00		
Direct overhead control			
able variance	113 79		
General overhead control			
able variance	23 71		
Total favorable cost variances		285 50	
Net unfavorable cost variances			049 61
Cost of Goods Sold (actual)			85 420 58
Gross Profit			\$ 25 579 42
Marketing Expense			19 440 00
			6 139 42
Administrative Expense			5 000 00
Net Operating Profit			\$ 1 139 42
Other Expense			
Direct overhead capacity variance			46 30
Other Income			1 093 12
General overhead capacity variance			21 59
Net Profit to Surplus			\$ 1 114 71

Fig 20 Segregated Capacity Variances in Profit and Loss Statement

over a period of years in the future, particularly if the number of years chosen on which to base sales expectancy coincides with the span of the business cycle for the specific industry

Some concerns follow the practice of crediting overabsorbed overhead to a reserve, against this underabsorbed overhead is charged until balance is exhausted. Further amounts of underabsorbed burden are handled in some other way. Along this line the following statement by Chubbuck is of interest (N A C A Year Book 1940)

I am of the opinion that generally speaking, to be consistent over absorbed and underabsorbed expenses should be balanced against each other over a period of years for purposes of annual statements as well as for monthly statements. I recognize however, that there may be certain practical objections to doing so and therefore, generally I am inclined to think of these amounts at year end in connection with an equitable

application to and adjustment of standard operating results and inventory. However there are companies which dispose of such amounts of overabsorbed and underabsorbed burden in their entirety either as direct charges or credits to profit and loss or as adjustments of the cost of sales which has substantially the same effect.

The practice of balancing overabsorbed and underabsorbed expenses against each other over a period of years is strongly objected to by some accountants. Thus, Rohrbach contends that each fiscal year should stand on its own feet, that the overhead accounts should be adjusted before the records are closed for any fiscal year and that reserve accounts as they affect overhead should not be carried forward from year to year.

**Adjust Cost of Sales and Inventories**—This may be accomplished through the use of a supplementary rate. This rate times the number of hours or dollars in work in process, finished goods, and cost of sales provides the necessary adjustment to dispose of under- or overabsorbed overhead. As a result, accounts are brought to an actual cost basis so far as overhead is concerned. Supplementary rates may be applied also to lines of product or to job cost cards, thus obtaining actual costs per unit of product. When the purpose is to obtain an over-all adjustment for balance sheet presentation, or tax returns it may be obtained by the following computation:

$$\frac{\text{Overhead in work in process}}{\text{Total overhead applied during period}} \times \frac{\text{Total under or over absorbed overhead}}{\text{Total overhead applied during period}}$$

= Adjustment to work in process for under or overabsorbed overhead

Similar computations are made for finished goods and cost of sales.

**Summary of Procedures**—The best indication of actual procedure followed in disposing of over- or underabsorbed overhead is found in the results of a study covering 325 companies. The data are presented in Fig. 21, taken from a special study (NACA Bulletin, vol. 21). The following conclusions may be drawn from the data:

1. The most general practice is to debit or credit over and under absorbed burden to cost of goods sold or to show it as additions to or deductions from cost of goods sold. Such balances are treated as cost of goods sold items in about twice as many companies as they are treated as profit and loss items.
2. As is to be expected inventories are more frequently adjusted by the proration of overabsorbed burden to inventories than by the proration of underabsorbed burden and thus adjustment of inventories is made more often at the end of the year than at the end of the month.
3. Some companies attempt to carry the theory of normal overhead to its logical conclusion as witnessed by the nine companies which treat year end overabsorbed balances as reserves to absorb future underabsorption and by the ten companies which either charge year end underabsorbed balances against such reserves or carry them forward to the next period. Naturally a considerably larger group carry month end balances forward.

The effect of the war emergency on this problem is shown by a more recent survey dealing with accounting for excess labor costs and overhead under conditions of increased production (NACA Bulletin vol.

Methods of Disposing of Over and Underabsorbed Burden	OVERABSORBED BURDEN		UNDERABSORBED BURDEN	
	End of Year Treatment	End of Month Treatment	End of Year Treatment	End of Month Treatment
1 Balance overabsorbed treated as a re- serve balance underabsorbed charged against reserve or carried forward	9	35	10	37
2 Balance overabsorbed credited to cost of goods sold, balance underabsorbed deb- ited to cost of goods sold	65	38	72	39
3 Balance overabsorbed shown separately as deduction from costs of goods sold, bal- ance underabsorbed shown separately as addition to cost of goods sold	59	46	62	46
4 Balance overabsorbed treated as other in- come below gross profit, balance under- absorbed charged to profit and loss be- low gross profit	57	52	58	53
5 Balance over or underabsorbed divided, pro rata, between inventories and cost of goods sold	19	7	8	1
6 Unclassified		3		3
Totals	209	181	210	179

FIG 21 Summary of Methods of Disposing of Over and Underabsorbed Burden  
Showing Number of Companies Using Each Method

22) There seems to have been no pronounced change in practice and the report concludes

Whether the small variance in practice shown by these two studies is due to a change in practice as a result of the increased tendency toward overabsorption between the dates of the two studies or due to the difference in the make up of the two groups of companies it is not possible to say. However, the findings in the two studies do definitely indicate that it is general industrial practice to treat overabsorbed burden like underabsorbed burden as a profit and loss adjustment that in only from 10% to 16% of the companies is it the practice to divide the overabsorbed amount between inventories and profit and loss and that the carrying forward of the unabsorbed amount is less frequently found than the other two practices. Undoubtedly the reported practices have been influenced somewhat by the fact that overabsorption during recent years has not been as common as underabsorption and probably in the case of individual companies has been of small amount.

**EXTENT OF OVER- AND UNDERABSORBED OVERHEAD**—The extent of the departure of actual from normal overhead is indicated in a recent survey (N A C A Bulletin, vol 22). Over a ten-year period, 122 companies using normal capacity reported a total of 823 years underabsorbed and 315 years overabsorbed burden. For the same period, 56 companies using expected volume showed 273 years underabsorbed and 220 years overabsorbed burden. Concerning the first group, Raymond P. Maple comments

It points to a tendency to overestimate normal capacity, or better to state normal capacity or volume at a figure somewhat higher than average volume. Of course the results shown here are not conclusive the amount of overabsorption in three active years might be sufficient to offset the underabsorption in seven less active years, but they tend to support a feeling in some quarters that even those accountants who subscribe to the theory that normal represents the average ability or capacity to produce and sell over a period of years have a tendency in applying this concept to set normal capacity at a figure somewhat higher than average.

A specific case study is reported by Chubbuck (N A C A Year Book 1940) of a company building machine tools, lathes and similar equipment. The practical capacity of the plant amounted to 600 000 direct labor hours per eight-hour shift. However, this had never been utilized, and the average rate of operation for the industry had been about 60% of capacity. As a result of forecasts made the company set 350 000 direct labor hours as normal utilization, and set their normal rate for absorption of fixed expense on that basis. The results in terms of under- and overabsorbed overhead are presented in Fig 22. It is explained by Chubbuck as follows:

Columns 1, 2 and 3 present the actual direct labor hours, the actual manufacturing expenses and the actual absorbed manufacturing expenses respectively for the twelve year period from 1929 to 1940 inclusive. Columns 4, 5, and 6 set forth according to fixed and variable components the budgeted amounts for the actual direct labor hours shown in column 1. Columns 7, 8 and 9 give an approximate analysis of the under- and overabsorbed expenses shown in column 10, which, of course, is the difference between columns 2 and 3.

With the exception of 1929 and 1930 the figures in column 9 represent the difference between the sum total of departmental burden com

puted on departmental rates and the overall burden rate of \$1.799 (\$1.714 per hour fixed and \$1.085 variable)

Column 8 represents the differences between column 4 the long term budgets for the respective levels of operation, and column 2 the amounts actually expended and in this case generally anticipated by the annual budget. Such differences relate particularly to expenditures for experimental work, salaries of shop departmental executives and key men, repairs and overtime work not anticipated by the study of overhead made some time ago and encountered now by reason of changed conditions.

Column 7 sets forth the differences or variances between absorbed and expended fixed manufacturing expenses which are attributable to activity at greater or less levels than that contemplated by normal activity. The net effect of columns 7, 8, and 9 is reflected in column 10 in which are presented annual net amounts of overabsorbed or underabsorbed burden which are to be considered for adequate and satisfactory accounting treatment.

The accounting treatment of variances in manufacturing expenses is the same both for purposes of monthly statements and year end statements—they are invariably disposed of as adjustments of standard gross profit.

**EFFECT ON INVENTORY VALUATION**—The effect of over or underabsorbed overhead on inventory is usually negligible especially since in good and bad years the two tend to offset each other. Concerning this point, Chubbuck (cited above) states:

Overhead costs have been included in unit costs by the use of normal rates. However, the utilization of plant during each of the most recent six years referred to in the tabulation has been at a level which is considerably in excess of what is considered normal utilization. Therefore, during those years the fixed components of overhead included in cost as first computed on a job cost basis are considerably in excess of the annual expenditures and accruals therefor (see column 7 Fig. 22) although variable components of overhead which have for most of those years, at any rate, exceeded the amounts contemplated by the normal overhead rates (see column 8) have offset in a measure the overabsorbed fixed expenses.

At this point in cost determination, which is on a job cost basis, there has been a considerable net amount of overhead included in unit costs and thus in inventory in excess of actual expenditures and if there were no other considerable factors, it would probably be advisable for purposes of the annual balance sheet and profit and loss statement to adjust the situation by pro-rating the net overabsorbed amount between profit and loss and inventory in accordance with the relative amounts of goods sold and on hand which had been produced during the year.

**REVISING NORMAL RATES**—In setting rates for the application of overhead to product based on estimates of the coming year only, the usual practice is to permit these rates to stand until the close of the period. Overabsorbed overhead in some months is offset by underabsorption in others. Logically the same procedure may be applied to normals based on sales expectancy. While a year is the length of time necessary to even out seasonal fluctuations, the span of the business cycle is the normal period for smoothing cyclical fluctuations. Furthermore, over- or underabsorbed overhead at the end of each fiscal year should not be closed but should be carried forward until the end of the cycle. Each concern needs to establish its own cycle through the use of

MANUFACTURING OVERHEAD AND CERTAIN RELATED STATISTICS  
(Cents omitted)

Year	(1) Actual Direct Labor Hours	(2) Actual Manufacturing Expenses	(3) Actual Absorbed Manufacturing Expenses	(4) — (5) — (6) MANUFACTURING EXPENSE BUDGET			(7) <sup>a</sup> — (8) <sup>b</sup> — (9) <sup>c</sup> — (10) <sup>d</sup> VARIANCE—MANUFACTURING EXPENSES			
				Total	Fixed	Variable	Volume	Expenditure	Other	Net Total Under- or (Over) Absorbed
1929	730 658	\$ 1 082 641	\$ 1 087 875	\$ 1 042 807	\$ 250 000	\$ 792 807	(\$ 271 715)	\$ 40 834	\$250 850	\$ 25 906
1930	411 264	832 658	599 844	606 221	250 000	446 221	43 642	156 487	140 019	252 814
1931	171 621	510 433	254 059	436 241	250 000	186 241	137 441	74 191	64 741	256 373
1932	112 803	384 149	147 439	371 843	250 000	121 843	109 815	12 301	84 507	226 713
1933	80 105	239 535	744 038	350 913	250 000	54 913	192 805	( 365 )	50	193 470
1934	224 156	483 595	339 910	433 209	250 000	243 209	59 063	37 613	13 340	75 652
1935	531 491	754 144	1 030 729	880 917	250 000	680 917	(155 535)	(156 773)	9 773	( 282 885 )
1936	626 541	902 034	1 157 090	1 233 758	250 000	679 758	(187 350)	( 37 792 )	(20 844)	( 555 065 )
1937	922 045	1 341 158	1 710 688	1 256 375	250 000	1 006 375	(404 311)	50 783	(30 030)	( 369 028 )
1938	533 150	1 043 086	939 548	862 415	250 000*	577 415	(148 194)*	180 671	21 031*	35 528
1939	868 079	1 437 415	1 634 706	1 227 516	250 000*	942 516	(422 185)*	239 899	14 915*	( 147 281 )
1940	1 200 000	2 000 000	2 250 000	1 587 000	250 000*	1 362 000	(691 805)*	413 000	28 800*	( 250 000 )
	6 441 073	\$11 100 843	\$11 371 757	\$10 115 253	\$3 105 000	\$7 010 253	(\$1 765 091)	\$1 045 585	\$512 192	(\$210 914)

Direct labor hours

Normal rate per direct labor hour

350 000

{ \$1 769

{ \$1 899

{ \$1 814

{ \$1 085

{ \$1 085

{ \$1 085

{ \$1 085

{ \$1 085

{ \$1 085

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a Col 5 — (Col 1 × \$714) or Col 5 — (Col 1 × \$814)

b Col 2 — Col 4

c (Col 1 × \$1 799) — Col 3 or (Col 1 × \$1 899) — Col 3

d Col 2 — Col 3

FIG 22 Long Range Fluctuations in Over and Underabsorbed Normal Burden

special purpose induces. In an article on Measuring Plant Capacity (N.A.C.A. Bulletin, vol 16) James says

If business men could foresee the future and confidently predict the so called secular trends of their own enterprises it would be safe for them to predetermine normal capacity projected over an economic cycle, which may or may not be a period of ten years. But forecasts have so far not attained to any such trustworthiness. Until they do so, if ever, business prudence dictates that they be revised annually.

### Idle Time and Idle Capacity Costs

**DEFINITION OF IDLE CAPACITY**—Losses due to idleness of workers and of plant facilities occur in the most carefully managed plants. Certain of these losses are unavoidable, but excessive idle time costs represent one of the urgent problems concerning which management must be kept informed. It is the duty of the cost analyst to segregate these costs into those which are controllable and those not controllable. On the basis of this information he must attempt to interpret the costs and place responsibility accordingly.

Idle plant is equipment which is not being used, whether for a day or for a year, and idle plant costs are the fixed or "stand-by" charges on this idle equipment. Idle capacity has been defined by James (N.A.C.A. Bulletin, vol 16)

Idle capacity represents the average unutilized portion of the plant and equipment over a long enough period of time to level out the peaks and valleys which come with seasonal and cyclical variations. It should be noted that the normal capacity plus idle capacity equals potential operating capacity.

McNiece (N.A.C.A. Year Book, 1927) defines idleness expense as

That amount of fixed burden which fails of absorption when charging operating cost with expense at the standard (i.e., normal) burden rate.

**IDLE CAPACITY AND FIXED CHARGES**—Idle capacity costs are represented mostly by the fixed charges of maintaining equipment not used. Increased mechanization of industry has introduced a constantly greater proportion of fixed charges. Unlike unskilled labor, machinery cannot be dismissed in periods of low production. As stated by Fiske (N.A.C.A. Bulletin, vol 13)

Plant costs include both building and equipment factors and may not be checked by lay off once an investment has been made. In periods of depression, idle space and machines represent largely noncontrollable costs.

On the other hand Hanley (N.A.C.A. Year Book, 1938) states his conclusions on idle capacity as follows:

Dispose of the equipment and get rid of the facilities when you are sure they are definitely idle because a shrinkage in capacity will occasion a shrinkage in organization and hence a shrinkage in the expense of stand by labor as well as in taxes. Furthermore any reasonable amount of salvage is so much more available working capital. Eliminate idle plant expense from unit costs because it is not truly a cost but actually a loss.

**VOLUME VARIANCE AND NORMAL CAPACITY**—Definitions of idle capacity imply that, generally speaking idleness expense is the unabsorbed portion of the fixed charges. Underabsorption of variable expense is not an idleness expense, and is not subject to the same accounting procedure when standard cost methods are employed. In effect, the definitions given above make the volume variance a measure of idleness expense. This is true under the following circumstances:

- 1 When normal capacity is set on basis of practical operating level
- 2 When operating interruptions are accurately determined based on adequate scheduling and dispatching proper functioning of internal transportation proper control of materials and good tool control and machine maintenance

Volume variances do not measure idle capacity costs when normal capacity is based on sales expectancy. Different formulas and procedures are used in practice to determine idle capacity and its cost. Frequently, the accuracy of the cost of idle capacity reported in a specific case depends on the accuracy with which a concern's normal capacity has been determined and the base used in setting the normal. Thus in a description given by McNiece (NACA Year Book 1927) it is stated:

In those plants suffering from extreme variations in load standards of expense are set up departmentally for a standard output and the product is charged each month with the expense at a standard rate the difference being charged or credited to the idle capacity expense account which amount in turn is charged off each month against profits. This eliminates most of the troublesome variations in production cost that arise in variable load and makes any variations from other causes more significant.

From the above comments the following points may be summarized:

- 1 Idle capacity must remain a somewhat flexible concept. It is an individual problem in which many special situations must be considered.
- 2 Management is interested in idleness, its causes and costs as well as in the more restricted accounting concept of idle capacity.
- 3 In many cases the volume variance, or unabsorbed fixed overhead is not the measure of idle capacity cost.
- 4 Special reports of idle equipment time and its cost are needed in which complete segregation of causes is necessary.
- 5 Wide differences exist regarding the extent to which idle time costs and idle capacity cost should be charged to the product produced. Possibly a majority of cost men agree that excess capacity costs should be excluded from product cost, while the expense of maintaining a key organization should be included.

**CAUSES OF IDLE TIME**—Fiske (NACA Bulletin, vol. 13) lists idle time as due to:

- 1 Production causes
- 2 Administrative causes
- 3 Economic causes

The first covers such purely internal causes as machine breakdowns, material shortages, poor scheduling, routing, etc. The second group represents matters of administrative policy in an attempt by management to reconcile internal plant conditions with the external conditions. The



third group represents the impact of external conditions over which management has little if any control

**Production Causes**—These are the most numerous and are most easily capable of being brought under control. They correspond largely to the internal causes mentioned above. Maze and Glover (Managerial Control) in their manufacturing chart of accounts classify idle time due to production causes as follows:

- 1 No power
- 2 Machine breakdown
- 3 Waiting for work

Idle time due to lack of power involves payment to productive workers (whether on an hourly or piecework basis) for time lost due to a cessation of the power supply. Power losses are so important that some plants maintain duplicate power sources. The same treatment as is indicated for power is used where the lost time is due to breakdowns in the mechanical or electrical equipment. Waiting for work involves payment to both productive and indirect labor for time lost because of lack of work. By thus segregating the causes of idle time in the accounts accurate information results which serves as a guide to management. The following reasons underlying the failure to achieve expected production levels represent a more complete classification of "lack of work":

- 1 Poor planning by production department
- 2 Poor planning by foreman
- 3 Lack of material. This in turn may be due to
  - a Failure of stores department to reorder when minimum was reached
  - b Delays in transportation
  - c Failure of vendor to meet specifications of purchase order
- 4 Lack of tools
- 5 Lack of inspector
- 6 Lack of instructions
- 7 Lack of power. This may be due to
  - a Improper inspection and maintenance of power plant
  - b Breakdown of transmission wires
- 8 Lack of help
- 9 Machine repair
- 10 Break up of job
- 11 Waiting for set up

It is clear that in part each cause is traceable to poor organization for operation. If there is a lack of work, for example, it may be due to poor planning, slow or delayed engineering analysis, poor routing, scheduling or dispatching, or lack of sales orders. It is seldom possible to eliminate or completely to control those causes but a positive knowledge of the extent of machine idleness and its causes provides management with something constructive to work on.

Loss of time due to any of these causes may be either entirely within or without the control of the factory management. Action must be based on proper reports. Thus Lewis (N.A.C.A. Bulletin, vol. 22) advocates use of a report on machine utilization and idle time (Fig. 23). To be effective it should be supplemented by a detailed analysis of idle machine hours and then cost.

## MACHINE UTILIZATION

Dept.

Number of Machines		Total Actual Production Hours Per Month	Total Normal Production Hours Per Month	Actual Production Hours Per Month	Idle Hours Per Month
Type & Description	Number				
100 B & S A 1 Screw Machine	16	No. of months times 40 hrs time of working days in month	Total Actual Production Hours less down time for set up repairs and maintenance	Actual Working time of machines for the month	Actual Idle time of machines productive hours
2 B & S Auto Screw Machine	5				

- A. The foregoing serves to establish purchases of new equipment when existing facilities are not being used to normal capacity.  
 B. It stimulates inquiry as to cause of idleness. This may be due to excessive breakdown caused by age or by improper maintenance.  
 C. It may permit disposition of excess facilities, thus reducing fixed charges and increasing cash balance.

FIG 23 Analysis of Machine Utilization

Determination of the responsibility for idle time losses is at all times difficult. The same factor in a given department may be due to a number of different conditions at different times. For example, idle time caused by waiting for work in Department 5 may be due to poor planning in the factory office, or it may be due to a failure to maintain scheduled production in Department 4. Further investigation may show that Department 4 suffered machine interruptions, necessitating extensive repairs. This in turn may be due to faulty maintenance practice. It may have been due to failure of power or failure to obtain the necessary parts or raw materials for processing. Innumerable reasons may lie at the root of the idle time in Department 5. The cost analyst is, therefore, always confronted with the necessity of judging which of the many reasons or excuses offered is the real cause of the idle time loss.

**Administrative Causes**—Under this category occurs idle time occasioned by administrative decisions. Thus, in building plant additions, capacity in excess of what is currently needed must be provided for future growth. Where skilled labor is used, management is often unwilling to dismiss such labor in periods of depression, as the cost of rehiring and retraining a new force exceeds the cost of maintaining the present organization. It is for this reason that in recent years some automobile manufacturers have worked out a scheme for guaranteeing their workers a minimum annual wage. Under this scheme a trained working force is maintained and the amounts paid the workers during lay-offs are adjusted when the men once more start working. A somewhat different scheme is cited by Sanders (*Problems in Industrial Accounting*) in the case of a brass works, employing highly skilled workers in one department. During periods of subnormal production these men are shifted into another department, where less skill is required. The difference between normal wages in the second department and the wage scale paid to the skilled workers is charged to an unabsorbed labor account in the department where the idleness required a shift.

The same source cites also the case of a rubber manufacturing plant, which, as the result of a merger, concentrated all production in one plant. Due to adverse market conditions the old plant could not be sold. Since the carrying charges of the old plant were beyond the control of the operating executives, they were carried as nonoperating expenses in the profit and loss statement.

**Economic Causes**—Idle time costs arising from economic causes are classified as

- 1 Seasonal
- 2 Cyclical
- 3 Industrial

For certain goods, where demand is seasonal, as in coal, ice cream, furs, straw hats, etc., production cannot be evenly distributed, especially where there is danger of deterioration or where carrying charges for a large stock are too great. Unused capacity can be reduced sometimes by taking on other seasonal products, whose peak coincides with slack seasons of the first product. An example of such cases might be the combination of milk and ice-cream production, the sale of coal and ice, the manufacture of steel toys by an automobile stamping company. On this point Fiske (N.A.C.A. Bulletin, vol. 13) writes:

If such complementary businesses cannot be found there will be an avoidable seasonal idle time. There are alternate periods of feverish activity and extreme dullness entirely beyond control of the individual concern.

Sanders (Problems in Industrial Accounting) cites the case of a beverage company which determined unit costs by dividing the total production into actual expenses. The resulting unit costs were confusing and not indicative of changes in operating efficiency. Seasonal fluctuations are normal in this industry, hence a standard hourly rate was developed by dividing normal hours of production into total annual expenses. Normal production hours are exclusive of idle time, hence total costs are absorbed by normal production hours producing over- and underabsorbed expenses in different months, depending upon the rate of activity. In this way variations in unit costs are due to variances in material used and in production per hour, that is, to operating efficiency.

Cyclical fluctuations are similar to seasonal fluctuations, but they exert their influence over longer periods of time and are equally beyond the control of management. Fiske (N.A.C.A. Bulletin, vol. 13), however, suggests that some of these losses can be controlled to some extent by proper long-range planning.

Thus losses arising from unused capacity may be reduced by maintaining a productive capacity less than that apparently called for at peaks of prosperity. In such a case, the extra capacity needed at the peak may be provided through overtime night shifts, or by letting out work thus avoiding the idle time resulting from acquiring extra capacity needed for short periods only.

This makes the task of the cost analyst more difficult in interpreting the results of operations. He must keep in mind the extent to which these results are affected by cyclical causes. For example, one large manufacturer attempts to cut idle time losses from cyclical causes by

using the plant facilities, labor, and managerial staffs to build plant additions during the contraction phase of a business cycle, and in other ways lay the groundwork for periods of ensuing prosperity. Long-range planning can do something to break the force and impact of a depression.

Under the heading of industrial causes come those idle time losses due to general shifts in demand producing overcapacity in some industry at a given time. Examples are the coal industry in England, the woolen industry in this country. Fiske (cited above) mentions the cotton industry, in which the shifting demand from cotton to silk and rayon has been a factor in creating a chronic condition of overcapacity in this industry. Another factor has been the relocation of industries made necessary by changing economic conditions and the westward movement of the population. Thus nearness to raw material and favorable conditions in the labor market have caused a large portion of the cotton industry to move south, creating overcapacity and dislocations in the economy of the New England states.

**SEGREGATION AND ACCUMULATION OF IDLE TIME COSTS**—The ultimate aim of the production man is to eliminate idle time costs, failing that to place responsibility for them. Since there are different causes for idle time, it is necessary to think of such costs not in terms of segregation of a single item but of a group of expenses. It is for this reason that Fiske states (N A C A Bulletin, vol. 13)

Probably the greatest error which has been made in treating it (idle time expense) in the past has been to lump all types of idle time costs together thereby including both controllable production idle time with noncontrollable economic idle time in the same account. By setting up a procedure to accumulate the costs of idle time arising from the various important sources it may be possible to take steps to reduce the sources of greatest loss. If management were interested in total costs alone there would be no need of keeping records of cost of idle time since it could be included by neglect but if the management is interested in information as a basis for control it is necessary to accumulate information regarding the cost of idle time.

Blocker (Cost Accounting) outlines a useful method for the segregation of idle time costs. He advocates classification of idle time as a separate factor in daily time tickets, as follows:

Each ticket should show the amount of time expended on each production order, the time consumed in performing indirect labor as a regular or special assignment, and the hours of nonproductive labor or idle time. If idle time is a normal condition of plant operation the following entries are made when the indirect labor payroll classified as to indirect labor and idle time, is distributed:

Entry in general ledger

Factory Overhead Expense

Payroll

\$

\$

Entry in subsidiary records

Charge appropriate departmental standing orders for indirect labor and for idle time

A separate standing order is maintained for idle time so that executive attention is directed to the idle time factor and to the department responsible.

Under the above method, idle time is reflected in product cost. However, idle time due to abnormal conditions beyond the control of the production division should be treated, according to Blocker (Cost Accounting), as a general profit and loss charge.

Examples of situations which might cause an abnormal amount of idle time are a strike, a lock out, a breakdown in machinery, fire, wind, or water damage, any one of which may require the maintenance of a skeleton force of workers even though there is no immediate productive work to be done. If the amount of idle time is deemed abnormal and its cost excessive, entries can be made debiting Loss Due to Idle Time and crediting Payroll when the payroll is distributed and debiting Profit and Loss and crediting Loss Due to Idle Time when the books are closed at the end of the accounting period.

Alden (NACA Year Book, 1924) outlines a method for the segregation of idleness expense as follows:

- 1 The plant is departmentalized, normal production in each department being fixed at 80% of theoretical maximum.
- 2 Fixed charges in each department are determined. These include salary of works manager, superintendents, foremen, etc., indirect labor essential for the carrying on of manufacturing, minimum coal requirements in powerhouse, depreciation, insurance, taxes, etc.
- 3 Each month a number of productive hours and unavoidable unproductive hours in each department are determined from time ticket analysis.
- 4 The total obtained in step 3 is divided by the normal hours. This yields a percentage of operating activity.
- 5 Percentage of operating activity is subtracted from 100% to yield a percentage of idleness.
- 6 The percentage of idleness is then applied to the fixed charges to determine what proportion of the fixed costs represents idleness expense. In the case of service departments the percentage of idleness of the factory as a whole is used.

Thus, assume that the press shop operated 60% of normal and the entire plant operated 75%. Then the idleness of the press shop is 40% and of the plant as a whole 25% and, if the fixed charge for supervision in the press shop is \$100, the charge against idleness for this item would be 40% of \$100 or \$40 and if at the same time, the cost department had a fixed charge for supervision of \$50, the charge for idleness in this case would be 25% of \$50 or \$12.50.

The advantages of this method as stated by Alden are:

- 1 That the amount of this expense is definitely known and the contributing factors are completely analyzed so that the management is kept in close touch with the situation and is therefore in a position to take such steps as may be necessary to bring about an improved condition.
- 2 By this means losses occurring from lack of operation are charged off as they occur thus avoiding the inflation of inventories.
- 3 Costs are automatically compensated for varying degrees of production, thereby avoiding the necessity of falling back on estimated costs to obtain the same results.
- 4 This permits the costs obtained to reflect variations in efficiency without obscuring this by other factors entirely outside the control of the factory management.
- 5 Correct figures are obtained for income tax returns.
- 6 From a credit standpoint banks look favorably on this method of accounting as it results in sound inventory values.

- 7 This system increases the effectiveness of figures given to foremen and others with the idea of helping them to increase the efficiency of their departments

**USE OF STANDARDS TO MEASURE IDLE TIME**—A serious defect of historical cost systems is that total costs must be absorbed each period in product cost. This is called **treatment by neglect**, since the cost figures do not segregate those costs properly chargeable to the product from those due to idle time. Thus Blocker (Cost Accounting) states

Since the labor cost is summarized for each process at the end of the accounting period and is divided by the total production to obtain an average unit cost, no recognition is given to the idle time element. It is correct to include normal idle time as a cost element under the general plan of process cost accounting because the goal is to obtain actual costs and some waste and inefficiency in the use of labor always exist.

Operating standards and standard costs may be used to advantage to obtain measures of idle time expenses. Knapp (N.A.C.A. Bulletin, vol. 14) gives an illustration taken from the experience of a cigar manufacturer. Idle capacity analysis is obtained as a volume variance in connection with a regular burden analysis statement.

Standard burden rates are set at normal capacity on the basis of practical operating level without regard to estimated sales. Standard burden is developed by departments and classified as fixed and fluctuating (variable), each class being expressed as a percentage of standard direct labor in the department (Fig. 24, columns 1, 2, 3, and 4). The amounts in column 4 are multiplied by the burden percentage to show the amount of each type of burden absorbed.

Standard direct labor  $\times$  Burden percentage = Burden absorbed

\$27,249  $\times$  37% = \$1,082 (Variable burden absorbed)

\$72,249  $\times$  35% = \$9,537 (Fixed burden absorbed)

The above figures are for Department 10. Actual fixed and variable burden are recorded in columns 6 and 9, respectively. Standard burdens in the product are entered, respectively, in columns 5 and 8. **Operating efficiency** (column 7) is determined by a comparison of figures in columns 5 and 6. **Volume or idle capacity variance** (column 10) is found by comparing figures in columns 8 and 9.

**DISPOSITION OF IDLE CAPACITY LOSSES**—Practice in disposing of idle capacity expense varies. In general it seems to be agreed that normal production losses should be absorbed in product costs, abnormal losses should be segregated and treated as nonoperating expense. In this category would, of course, be included those non-controllable idle time losses due to economic and administrative causes. Many companies charge off such losses to profit and loss. However, for purposes of cost control, some companies compute idle time costs on their leading products by the use of statistical techniques (Fig. 25). In the processing departments, idle capacity is expressed as a percentage of standard labor cost. This percentage is then applied to each product as shown in column 2. In the making departments, idle capacity cost is computed on the basis of the actual production, and in the packing departments on the basis of the number of cigars handled.

(1) Depart ment	(2)	(3) Standard Burden %	(4) Standard Direct Labor	(5) Fluctuating Burden			(7) Varia tion	(8) Fixed Burden			(10) Idle Capacity
				Standard Earned	Actual			Standard Earned	Actual		
10	Fluctuating	37 00	\$27 249	\$10 082	\$ 9 646	\$436		\$ 9 537	\$12 872	\$3 335	
	Fixed	35 00									
20	Fluctuating	30 00	1 078	323	369	46*		830	1 110	280	
	Fixed	77 00									
30	Fluctuating	16 00	3 564	570	674	104*		1 247	1 651	404	
	Fixed	35 00									
45	Fluctuating	68	1 141	776	691	85		1 643	2 169	526	
	Fixed	1 44									
50	Fluctuating	32	3 026	968	902	66		1 634	2 116	482	
	Fixed	54									
55	Fluctuating	55	1 190	655	628	27		1 131	1 538	407	
	Fixed	95									
58	Fluctuating	23	250	53	72	14*		383	511	128	
	Fixed	1 53									
70	Fluctuating	27	1 368	369	322	47		506	684	178	
	Fixed	37									
72	Fluctuating	75	1 695	1 271	1 214	57		1,271	1 717	446	
	Fixed	75									
Totals			\$40 561	\$15 072	\$14 518	\$554		\$18 182	\$24 368	\$6 186	

\* Denotes loss.

FIG 24 Report of Burden Variation and Idle Capacity

	(1) Direct Labor per M	(2) 20 92% of Standard Direct Labor	(3) Processing Depart- ments	(4) Making Depart- ments	(5) Making Depart- ments	(6) Packing Depart- ments	(7) Total
Idle Capacity Cost (from Fig 24)			\$1 210	\$3 335	\$ 624	\$1 017	\$6 186
Distribution Bases							
1 Standard Direct Labor (from Fig 24)			\$5 783				
% of Idle Capacity to Direct Labor			20 92%	7 012	1 926	9 538	
2 Cigar Production (in 000 s)				\$ 438	\$ 324	\$ 107	
Idle Capacity Cost per M							
Idle Capacity charged to Products							
Londres	\$ 4913	\$ 103		\$ 438		\$ 107	\$ 648
Perfecto	6623	139		438		107	684
Cabinet	5856	123		438		107	668
Panetela	44	092		438		107	637
Endicott	7061	148		438		107	698
Midget	4508	094			324	107	525
Junior	4943	103			324	107	534

FIG 25 Idle Capacity Cost Applied to Product



In connection with a research study on practice regarding disposition of idle equipment cost, Marple has stated (N A C A Bulletin, vol 19)

Replies show that 69 of the 224 companies eliminate from overhead and treat separately as idle equipment cost the fixed charges on idle plant and equipment not used during the period. Of these 69 companies 35 charge the idle equipment cost against profit and loss 10 against cost of goods sold and 4 failed to indicate the account charged.

# SECTION 21

## RESEARCH AND DEVELOPMENT COSTS

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## SECTION 21

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### RESEARCH AND DEVELOPMENT COSTS

#### Definition and Classification of Research

**DEFINITION OF RESEARCH**—Heberling (Bulletin 80, General Management Series, American Management Association) gives the following comprehensive definition of research as used in business

Industrial or commercial research is the search for ways of making a product or service better or a searching for new uses for it, a search for the best kind of organization to accomplish the purposes of the business, a searching for the best way to lay out a building to secure the greatest advantages of location and space, a searching for the best method of reaching new customers or billing customers for a service and keeping record of their account, or a search for the facts which indicate trends in a business, a searching for the best method of finding and presenting facts to executives to permit a ready and accurate interpretation so that a decision may be intelligently arrived at, plans constructively made and action soundly taken

Papenfoth (N A C A Bulletin, vol 22) discusses the nature of industrial research as follows

From an accounting viewpoint, in its broader aspects research costs include expenditures for the development of new products improvement of present products development of new manufacturing methods development of new and special machinery cost of purchased patents royalty on the manufacture of patented products, patent litigation expense testing products field service to cover supplementary development and to remedy complaints due to design of products after their delivery Specifically expenditures made embracing these purposes include the compensation of engineers and draftsmen indirect expense of engineering and drafting departments, experimental labor and indirect expense of the experimental department and material and expense incurred in manufacturing departments in making testing and inspecting initial products while in process of development

Research is now a normal part of the everyday work of numerous industrial firms throughout the United States According to a report of the National Resources Planning Board in cooperation with the National Research Council published in December, 1940 a total of 2350 companies have reported 70,033 persons engaged in technical research in industry in the United States The rate of increase of research personnel in industry for 1938-1940 is twice the average rate for the last twenty years A considerable number of small and medium sized companies conduct research However, most industrial research effort is sup-

ported by a comparatively small number of large corporations who spend annually for research in the physical and biological sciences alone 300 million dollars. Assuming the average cost of research to be \$4,000 per man-year, the ratio of research expenditures of an average company to its sales is 6%, and the ratio to its net income is 8%.

The above report covers only work in physical and biological sciences, since only chemists, physicists, engineers, metallurgists, bacteriologists, and biologists are reported. The whole realm of the social sciences is not covered, yet for many concerns research in advertising, marketing, accounting and other phases of their business is very important. For many work of this sort may be the only kind of research carried on.

While much research results in new products, in reality most efforts of research work result in improvements in old products or better ways of doing certain things. In a competitively organized society improvements in product of one competitor may enable him to secure a larger share of the available business. His competitors to retain their share, must in turn improve their product or allow a sufficient price differential to bring adjustments among competitors.

Research, therefore, using the term in its broadest sense, results in real improvements in products and processes of manufacture and marketing, and yet may enable a given business barely to keep in the running with vigorous competitors. This is particularly true in the newer industries where new uses and new processes of manufacture are being developed most rapidly.

**TYPES OF RESEARCH**—Heberling, cited above, states that research can be carried on in the fields of

1 Management	13 Selling
2 Administration	14 Distribution
3 Organization principles and application	15 Plant layout
4 Direction principles and application	16 Production equipment
5 Supervision	17 Production control and methods
6 Public relations	18 Financing
7 Industrial relations	19 Budgeting
8 New products	20 Accounting
9 Design of products	21 Ratios
10 Market	22 Cost finding
11 Advertising	23 Statistics
12 Merchandising	24 Office methods
	25 Measurement of work

While research may consist of any or all of the types of work just listed, the major problems center around research costs in a narrower sense. Papanof, cited above, suggests that most problems concerning research and development costs can be grouped into four types:

1 Development work on manufacturing methods, if considered under the category of research costs may be charged directly to manufacturing expense since in most cases this is an ordinary expenditure in the course of manufacturing and in the improvement of manufacturing methods. However, some unusual conditions might exist where one would be justified in setting up some such major expenditure under deferred charges to be liquidated over a reasonable period of time.

2 Development work on new products is quite generally charged to deferred expense and liquidated over production through cost of sales or

directly to profit and loss as an income deduction. Obviously, as the treatment varies with respect to this expense even within the same industry cost comparisons between manufacturers would tell little or nothing unless the basis of costing were clearly understood. Another point for consideration with respect to the manner in which this expenditure is liquidated is the effect on inventory valuation. If charged to factory burden when liquidated, the valuation of inventory on the basis of manufacturing costs would be inflated by the relative amount of development and research expense included therein.

3 Development work on products already manufactured covering minor changes and improvements would be charged generally to manufacturing expense.

4 Pure research, assuming that such research is not directly associated with regular manufacturing processes or products may be charged to administrative expense or directly to profit and loss as an income deduction.

Results of a recent survey by the National Association of Cost Accountants (N A C A Bulletin, vol 20) show that most companies who reported have some classification of research costs. The classification on the questionnaire related to the following:

- 1 Development of new product
- 2 Improvement of present product
- 3 Development of new manufacturing methods
- 4 Development of new and special machines
- 5 Experimental testing of product
- 6 Testing of raw materials
- 7 Cost of purchased patents
- 8 Royalties on manufacture of patented product
- 9 Patent litigation expense
- 10 Pure research

**DEFINITION OF DEVELOPMENT COSTS**—The Standard Accounting and Cost System of the Electrical Manufacturing Industry defines development costs as follows:

Research and engineering expenditures preliminary to regular manufacture of products such as time of engineers and draftsmen, indirect expenses of engineering and drafting departments, patents purchased as liquidated annually payments in satisfaction of judgments for infringement of patent rights, royalties paid, all expenditures incurred for initial patterns, tools, molds, punches and dies in the development of an entirely new class, line or type of product preliminary to manufacture and all special tools, patterns, molds, punches and dies for special apparatus built to order, also labor, material and expense incurred in the manufacturing departments in making, testing, and correcting initial product in process of development.

Also expenditures incurred either before or after shipment of the company's product when due to faulty design or engineering specifications and when the result of failure of apparatus to operate satisfactorily is because of such defects.

Included also are costs of duplicate and replacement patterns, tools, etc. To summarize, research costs are those costs incurred in discovery of new ideas or processes by experiment or otherwise. Development costs are those costs connected with putting the results of research on a commercial basis. Since these are often carried on in engineering departments and since the accounting problems are largely the same for both the terms research, development, and engineering costs are often used synonymously.

**BUDGETARY CONTROL OF RESEARCH AND DEVELOPMENT COSTS**—The extent to which budgets are used for controlling research costs is shown by following tabulation (N A C A Bulletin, vol 20)

	Number of Companies
Research and development costs budgeted in total	26
Research and development costs budgeted by projects	27
Research and development costs budgeted by projects and in total both	14
Research and development costs not budgeted	37
Total	<u>104</u>

The existence of a separate research department and use of a budget to control research costs are closely correlated. According to Field, the following is typical of the special purpose budget of one manufacturer (N A C A Bulletin vol 15)

1 Development and experimental work in connection with new product and improvement of present product	\$120 000
2 Manufacturing preparation on item 1	75 000
a New tools or changes in existing tools	
b New patterns or changes in existing patterns	
c Special machinery	
3 Patent work	60 000
4 Relocation of machinery	10 000
5 Capital expenditures for buildings and standard machinery	50 000

**AUTHORIZING EXECUTIVE**—Final decision in authorizing individual research and development projects varies. By disregarding titles and considering only the general functions likely to apply to an executive with a specific title the following summary was developed in the research study of the National Association of Cost Accountants (N A C A Bulletin, vol 20)

Title or Position	Number of Companies
President	35
A committee	19
General manager	16
A vice president	12
Chief engineer or research director	10
Production superintendent or manager	6
Unclassified	8
	<u>106</u>

This tabulation is a simplification of a great variety of arrangements for securing final approval of research projects. In slightly more than half of the companies, either the president or a committee (of which the president is usually a member) makes the final decision. In some cases, only major developments need to be referred to a committee or the president. In many cases the committee is the executive or management committee, but in other companies special research committees, planning committees, construction and experimental committees





[illegible]

G	ESTIMATED ANNUAL SALES	CA ALICE NUMBER	QW IN 1 YR	UNIT COST	TOTAL COST	UNIT S	ELL W/FY	TOTAL L. NO.	C OPS O. NO.	TOTAL	
1	NEW APPARATUS ( 04 --- 04A 01)										
"	" " " "										
TOTAL NEW											
2	APPARATUS REPLACED ( 05---ACTN 1)										
"	" " " "										
TOTAL REPLACED											
3	ANNUAL GAIN										
H STOCK ON HAND											
1	FINISHED STOCK---SYRACUSE										
"	" " " "										
2	FINISHED STOCK---DISTRICTS										
"	" " " "										
3	PARTS STOCK --- SYRACUSE										
"	" " " "										
"	" " " "										
4	RAW STOCK --- SYRACUSE										
"	" " " "										
"	" " " "										
TOTAL											

Fig 1b Appropriation Request (Sheet B)

or budget committees have the final authority. In a few instances, final approval of the board of directors is required for major developments.

Frequently a distinction between major and minor projects is mentioned, with a major executive or committee passing on large expenditures, and the research director or production manager passing on smaller expenditures. Where the chief engineer, research director, or production superintendent decides on projects to be undertaken, it appears to be common practice to restrict this approval within limits of an annual research appropriation or to require final approval by a top executive or committee for major undertakings.

**CONTROL THROUGH STANDARDS**—Although research work is varied and much of it cannot be predicted with any accuracy yet in many instances various types of checks on performance in the form of standards have been developed and found useful. As research in certain fields is carried on over a longer period of time the greater experience in budgeting and setting of standards will yield better controls. Dittmar in discussing a paper by Amerman (Bulletin of Taylor Society and Society of Industrial Engineers, vol 1), said

In the research laboratory with which I am connected we are able very satisfactorily to control the cost of our research experiments by determining a laboratory overhead rate in the conventional way. Weekly time reports by our chemists enable the cost accounting department to determine the actual cost of each experiment carried out, the labor rate being that of the individual technician doing the job. This is the information in which we are vitally interested. It is an obvious assumption that no problem is entered upon unless it possesses a direct or indirect value to us. If the costs mount or threaten to mount higher than the value of the problem's solution, it naturally pays to eliminate such a problem. Our laboratory cost control gives us the means of doing this.

Field (NACA Bulletin, vol 15) describes the control over developmental expenses concerning improvement of existing product and perfection of a new product. With some slight variations this control could be extended to other research and developmental expenses. This method is described as

establishing a predetermined standard for a complete program of development and experimental work for each item of product to be considered and the manufacturing preparation that would logically follow successful work of this nature either as a new product or improvement of present product.

After careful study, a form entitled appropriation request (Figs 1a and 1b) was adopted for the recommendation of expenditures to be made during the year. These forms may be made out at any time during the year, but the total of such appropriations must not exceed the budget established at the beginning of year without special action by the executive committee. Each appropriation request is made in duplicate and includes only one proposal. As finally approved, it becomes the standard for work to be performed and is completely made out before each project is started. The form used consists of two sheets. Sheet A shows a detailed description of the work and the results expected, a summary of expenditures and net profit from sheet B, together with approvals required before release. Sheet B shows details of standards established

for each class of work, covering not only developmental and experimental work (item A) but also the manufacturing preparation (item F). This sheet also provides for various calculations of profit and loss expected from work recommended. Each appropriation, when completed, either shows a profit or a loss before work is started. Items on this are not necessarily all chargeable to expense but provide a total picture of the effect of all contemplated items necessary. If the proposed project shows a profit, the appropriation practically justifies itself and it is only necessary for all executives to look over the standards and assure themselves that they are proper for their particular division. If a probable loss on the project is shown, final approval may depend upon company policy, or sufficient reason may be shown to reject the request unless by another method a probable profit can be shown. The procedure according to Field, is as follows:

The chief engineer keeps a register of appropriation requests and assigns serial numbers to each. After registry, these are released and routed to executives for approvals:

- 1 General sales manager for approval of
  - a Time of release of product sheet A
  - b Disposition of stock on hand and time needed for same sheet A
  - c Quantities and selling prices sheet B paragraph G
  - d Disposition and sales value sheet B paragraph H
  - e In general all sales estimates and prices
- 2 Vice president in charge of operations
  - a All estimated costs sheets A and B and recommendations of engineering and manufacturing divisions
- 3 Treasury and controller
  - a Actual costs and actual quantities, sheets A and B
  - b General review sheets A and B
  - c Financial approval of the appropriation
- 4 President for executive approval and authorized release

After the appropriation is released an expense sales order is issued for the accumulation of actual costs and one copy is held at the point of origin (chief engineer) while the other copy is delivered to the accounting department with the expense sales order. Thereafter the controller is responsible for advising the president each month of the progress of work (actual cost vs standard) on all expense sales orders.

Field claims annual cost savings in excess of \$100,000 by one company upon the adoption of this method. Its successful operation requires the same careful establishment of correct standards as are made for the establishment of manufacturing standards for any regular product, although it probably is not as susceptible to as close standards as for manufacturing operations.

### SETTING STANDARDS FOR DEVELOPMENT COSTS—

Another system of controlling development costs is discussed by Frank (N.A.C.A. Year Book 1931). To assist in the predetermination of the costs of developing various products, a development cost sheet is used (Fig. 2). In arriving at a standard cost for a part (15A in this case), the following must be considered:

- 1 Previous estimates carefully checked
- 2 Actual performance records of similar work already done
- 3 Best judgment of engineering and production executives



Assuming that standards exist for materials, labor, and burden for all production departments, the cost department can enter costs for material, labor, and burden applying to the various classes of work at rates established in the various centers where the work is to be done. In addition there are **standard costs of experimental work** involved in the development and approval of the item being worked on. In Fig 2 the estimated cost of a practical demonstration of the product or part is shown separately, though many might find it practical or adequate to combine this item with experimental expense shown on line above. The total **estimated cost** (\$232 71 in this case) is charged to future production in such ways as management may deem most appropriate. On the illustrated form, \$7 31 is shown as a charge to manufacturing order 16787 and the remainder is to be distributed equally over 400 pieces at \$46 each.

The total estimated or **standard cost** is charged to an Unapplied Development account. The variance between actual and standard is charged to Profit and Loss. As production takes place, charges are made to orders and corresponding credits are made to Unapplied Development account. Any unapplied balance is charged to Surplus when manufacture of the part or machine is discontinued. By keeping a record of charges and credits for development work, an actual control, much like a perpetual inventory record, is maintained and it can be reconciled by the detailed unapplied balances. The method is similar to that advocated in the Manual of the National Machine Tool Builders' Association except that the Unapplied Development account is charged at **standard** instead of at actual cost.

## Accumulation of Research Costs

### CONTENT OF RESEARCH AND DEVELOPMENT COSTS

—The Manual of Cost Procedures of the National Machine Tool Builders' Association states that development costs cover

- |                  |                               |
|------------------|-------------------------------|
| 1 Designing      | 4 Special dies jigs and tools |
| 2 Drafting       | 5 Demonstration               |
| 3 Pattern making | 6 Experimental work           |

Note that **experimental work** is included under the general heading of development costs. In turn these activities are applied to the collection and distribution of costs of

- |                          |                               |
|--------------------------|-------------------------------|
| 1 Production development | 3 Customers' or contract work |
| 2 Sales proposals        | 4 Plant assets                |

Production development includes the design and preparation of specifications, prints etc., for machines not previously built and for later improvements thereon. Sales proposals include engineering work in making estimates and prints for the sales department to secure future business. **Customers' or contract work** covers the design, specifications, blueprints, etc., necessary for the execution of production work sold to customers on a contract basis. Finally, **plant asset development** covers the design and engineering details for the construction of equipment for a company's own use.

**METHOD OF ACCUMULATION OF EXPERIMENTAL COSTS**—The following comment has been summarized from an article by Clark (N. A. C. A. Bulletin, vol. 15)

If development work is to be capitalized each project is assigned a number and all costs are charged to this order on a job cost basis. If costs are to be charged currently to expense, appropriate accounts are set up. Thus, according to the Uniform Accounting System of the Electrical Manufacturing Industry, costs pertaining to the completion of a project include

- 1 Compensation of engineers, chemists and draftsmen
- 2 Indirect expenses of the engineering laboratory and drafting departments
- 3 Cost of blueprints
- 4 Experimental labor material and factory expense incurred in the manufacturing departments in making testing, and correcting products while in the process of development
- 5 Expenditures for initial and duplicate patterns and molds, jigs, punches dies and other special tools i.e. those which are not commonly useful but are designed for specific types of products and the use of which is dependent upon a continuation of the production of that product
- 6 Cost of patents purchased from outsiders
- 7 Costs of patents obtained through the company itself. These include direct legal expenses of obtaining the patent plus a portion of the cost of a patent department if one is maintained, legal expenses in connection with the prosecution or defense of patent suits and payments in satisfaction for infringement of patent rights.

Those who believe that a portion of general expenses should be charged, add some general expense to the other development costs. According to a recent research (NACA Bulletin, vol 20), the great majority of companies assemble costs of research projects on a job cost basis.

Sixty nine companies report the use of job costs without comment while four companies state that job costs are sometimes used, are used for capitalized projects only or are used for major developments. Presumably in these companies which do not report the use of job costs the research expenditures are treated as overhead for the department in which the work is carried on.

A specific illustration of the procedure followed is furnished by Stevenson (NACA Bulletin vol 10)

We use the case system wherein each contract is given a number under which subcases dealing with specific problems can be opened when the work involved requires such divisions. The case or problem is then assigned to one group, a bound notebook bearing the case number is made up and the number entered upon the daily report records of those men directly involved. All laboratory notes, conference reports and library information go into these notebooks.

At the conclusion of each day every member of the staff is required to account for the distribution by hours of his working time. For this purpose a convenient card is provided, in the left hand column of which appear the names and numbers of the problems upon which he is engaged while one vertical column is provided for each working day in the month. These cards go to the accounting department and thence to the office of the research director where an accumulative record is kept showing the progressive status of work in hand.

In the accounting department the time spent in hours as above reported should be converted into dollars and cents. This involves fixing an hourly cost rate for each member of the research laboratory including salary, overhead, and direct expense. The charges as turned in for time mate-

ials special supplies and travel should be accumulated and prorated against the active problems. At the end of the month the research director should have access to these figures in order to budget intelligently the time of his group for the coming month and indirectly gain valuable insight into the cost of certain types of activities as compared with others.

**SOURCES OF DATA**—All charges are collected through the customary channels such as vendors' invoices, material requisitions, labor time tickets, time cards of engineers, chemists, and draftsmen, or a reasonable apportionment of such costs. If much experimental work is being carried on a special subsidiary ledger for such charges is appropriate and makes possible any desired classification of such expenditures. Another group of charges are those made in addition to costs already collected, on the assumption that the latter were capitalized. These operating charges are for:

1. Royalties paid under licenses from other patentees
2. Costs of work in remedying defects discovered after production has begun

Fig. 2 shows the form used by a machine tool manufacturer which provides for the accumulation of actual costs of a project. It is, in effect, a project cost sheet. These sheets are filed numerically by parts, assemblies or machine symbol. In addition, estimated costs are shown on the form. Concerning the latter, the Manual of the National Machine Tool Builders' Association which recommends this form states:

When all the actual costs have been determined it may be necessary to revise the estimates on the development cost form. A new sheet should then be written to replace the original.

For all succeeding estimates the cost data can be taken from these development cost sheets. If a part may be used on more than one type of assembly or machine the number of pieces and symbol number for each type should be inserted on the development cost sheet under "Used on."

(For use of standards in connection with this form, see discussion later in this Section.)

Authority for all development work is based upon special work orders (Fig. 3), copies of which go to the cost department. Ordinarily a separate work order is issued for each class of work to be done. Actual costs are collected on a job order basis, and are accumulated on the work order through the usual channels of material requisitions, time cards, etc. The cost department sorts these actual costs to conform to the classifications shown on the development cost sheet and enters them in the spaces provided by the columns on the right of that sheet. A work in process file is maintained subdivided by classes of development work. The Manual states:

The department performing the last work on the order turns in its copy of the order, noting thereon the date of completion. This constitutes notice to the cost department to calculate the cost of the order. Such costs are calculated as follows:

1. Post the major items of materials to the actual cost record (Fig. 3). Miscellaneous items of small value may be grouped in posting.
2. Accumulate the material costs into engineering patterns, and production and post to "Material" on the cost record.
3. Accumulate the labor and burden costs into engineering patterns, and production and post to the cost record.



SPECIAL WORK ORDER		
Date _____	Estimated Hours to Execute _____	Order No _____
Customer's Order No _____	Manufacturing Order No _____	
Blueprint No _____	Scheduled to Start _____	Scheduled to Finish _____
Charge Finished Work to	ACCOUNT NO _____	DEPARTMENT _____
DETAILS		
Issued By _____	Approved _____	Completed _____

FIG 3a Special Work Order (face)

MATERIALS USED					CREDITS Rate Per Unit		
Date	Quantity	Description		Cost	Date	Qty	Amount
		Engineering	Pattern	Production			
Material							
Labor							
Burden							
Total							

FIG 3b Actual Cost Record (reverse side of Fig 3a)

- 4 Add for "Totals "
- 5 Resort the cost tickets to conform to the breakdown of costs on the development cost sheet and post the total cost of materials, labor and burden to the "Actual Cost" section of the sheet (Fig 2)
- 6 Indicate the variance between estimated and actual costs on the development cost sheet as 'Operating—Gain or Loss'

**RESEARCH DEPARTMENT OVERHEAD**—Papenfoth also advocates use of the job order method. However, he treats the research department as in essence a service department to which must be charged plant overhead. Concerning this point, he states (N A C A Bulletin, vol 22)

The use of an individual authorization and subsequent accumulation of material and labor costs under an authorization or order number provides as a matter of routine the basis of an adequate subdivision and classification of these expenditures. Expenditures for material engineering salaries or clerical salaries applicable to research and development authorizations may be charged under any desired classification and present no problems provided that such salaries do not in any way require the application of overhead expense thereto. On the other hand, in operating the experimental department where supervision equipment and depreciation thereon, maintenance use of power and other incidental expenses are involved, we have the problem of overhead application. Experimental department overhead, as we visualize it, includes three divisions of expense charges:

- 1 Direct charges or assessments such as supervision, clerical labor handling and trucking machine and equipment maintenance and the usual run of direct charges
- 2 Fixed charges including taxes, insurance depreciation, and cost of floor space occupied, all of which may be assessed or allocated on a fairly definite basis
- 3 Prorated general expenses which would include a share of general factory supervision general clerical labor including cost clerks, purchasing department general maintenance depreciation and other factory operating or indirect expenses which cannot be directly charged to any regular manufacturing department

Under this system, **general factory expenses** are allocated to departments on some logical basis, and any remaining amount may be more or less arbitrarily allocated according to the relative amount of direct labor or direct labor hours included under these departments. Objection is raised frequently to the allocation of any general factory expenses to the experimental department since the resulting accumulated costs with overhead thus applied may inflate these costs if capitalized. To offset this point of view, the exclusion of any share of general expense in the experimental department overhead might very well be considered arbitrary and discriminating in placing a load on the production departments only.

## Disposition of Research Costs

**PRACTICE IN DISPOSING OF RESEARCH COSTS**—Two surveys of business practice in accounting for research costs have been made in the last few years. They show the general pattern of accounting treatment given to research and development costs. The first of these was made by the Chamber of Commerce of the United States and

appeared in 1937. The National Association of Cost Accountants also made a study on research costs and published the results in 1939 (N A C A Bulletin, vol 20). This is a comprehensive survey of current practices in accounting for research costs. The following material is based on information revealed by this study.

Of the 106 reporting companies 37 companies charge all research costs to a single profit and loss classification. The remaining 69 showed some degree of subclassification of research costs. Practice is thus seen to vary considerably, some companies treating all research costs as a unit charge to profit and loss, while others subdivide costs in a great variety of ways depending upon their own particular needs. Basically there are only two methods for liquidating or disposing of research costs:

- 1 Revenue basis
- 2 Capitalization basis

The results in the case of the N A C A survey, subdivided by types of research are shown below:

#### ACCOUNTING TREATMENT BY TYPES OF RESEARCH COSTS

	Nature of Expenditure	Capitalized or Deferred Where Judged Successful	Charged Off Currently	Treatment Varies	No Answer
1	Development of new products	10	87	2	7
2	Improvement of present product	4	95		7
3	Development of new manufacturing methods	4	92	1	9
4	Development of new and special machinery	47	38	9	12
5	Pure research	1	86	1	12
6	Cost of purchased patents	46	25	2	33
7	Royalties on manufacturing of patented products	2	77		27
8	Patent litigation expense	4	75		27
9	Experimental testing of product		101		5
10	Testing of raw materials		97		9

**DIRECT CHARGING OF RESEARCH COSTS**—In addition to the basic methods shown above, there is the method of direct charging which can be used in combination with either the revenue or the capitalization basis. Examples are laboratory testing and research carried on for customers.

**Laboratory Testing**—The average laboratory does a great deal of work which is not at all experimental. It may check instruments, inspect, test, or analyze materials, both when received and during their progress through the plant, or it may make recommendations to the purchasing agent or analyze competitors' goods for the sales manager. Clearly, the cost of these functions must be segregated and directly charged to the appropriate department.

**Treatment of Research Work for Customers**—Many companies carry on research work on behalf of and at request of customers. Naturally, the ability to charge the customer depends largely on trade practice, and the desirability of doing such work depends somewhat on sales and price policies. The results of a survey (N A C A Bulletin, vol 20)

are shown in the tabulation below. The first column shows the number of companies reporting a single method of treating the cost of research projects carried on for customers and the second column the number of companies reporting use of a particular method in conjunction with one or more other methods.

#### METHODS OF TREATING RESEARCH FOR CUSTOMERS

	Number of Companies		
	Using Indicated Method Only	Using Indicated Method in Conjunction with One or More Others	Total
Charged to customer's order	32	26	58
Charged to general overhead	17	15	32
Charged to selling expense	9	7	16
Charged to product overhead	1	1	2
Charged as separate profit and loss item	3	3	6
No answer			22

The National Machine Tool Builders' Association on the subject of research for customers states in its Manual:

Those companies using the deferred method of development cost application should report the unfinished work of this nature as work in process, closing the completed order costs from work in process directly to cost of sales when the contract is shipped from the company's plant and invoiced.

If predetermined costs have been established for this work, the variance between the actual cost and the established standard will be charged to operating cost and the standard cost amount applied to the cost of production order as shipped. The balance of work of this class will be charged to cost of sales at the actual cost.

**APPORTIONMENT OF RESEARCH COSTS**—The job cost method of collecting costs can be simplified where experimental work is a regular part of operations by allocating total research costs on an estimated rate basis. Ordinarily, however, cost sheets are used to gather actual costs. The latter are reduced to rates used to write off the costs against subsequent production. Thus the Machine Tool Builders' Manual states:

The management having indicated the number of manufactured units that should be charged with the development cost, the development cost per unit should be determined on that basis and the amount indicated on the actual cost record (Fig. 3) where it will be used in calculating costs of production.

Basically the application or liquidation of research expense depends on whether the resulting expenditures are to be capitalized (deferred) or charged immediately to expense. The Machine Tool Builders' Manual takes no definite position although it prefers the deferred method in theory. It states the case for each as follows:

1. Under the deferred method, all development costs are charged to an Unabsorbed Development Cost account under "Deferred Assets" thereafter.

crediting this account as the development costs are charged either to the product or to expense

If the deferred method is used extreme care must be exercised to see that the deferred asset account is credited with all charges that should be made to production or expense, also that the account be credited with all Unabsorbed Development Cost of discontinued parts and assemblies. If this precaution is not taken, the account is liable to become overstated thereby reflecting an untrue condition in the balance sheet of the company

2 Under the expense method all development costs are charged to an expense account termed Development Expense. The expense method has two advantages over the deferred method

- a By charging an expense account with all of the accrued expenditures for development, afterwards crediting this expense account with deferred charges to production and obsolescence the danger of over stating the assets of the company would be eliminated as the balance of the development expense account would always be carried as a nonoperating loss
- b In tax accounting those companies whose accounting methods are not well organized can best use this method

Figs 4 and 5, taken from the Manual of the National Machine Tool Builders' Association, show graphically the application of each method and the effect produced by each in the accounts. The detailed explanation covering each so far as it concerns production development is given in the Manual as follows

**Deferred Method**—Those companies electing to charge development costs to the product as manufactured showing any unabsorbed amounts as deferred expense on the balance sheet may use the following procedure

- 1 Charge the sum of the costs of all orders completed during the accounting period, to Unabsorbed Development Cost
- 2 Apply development cost to production orders on the basis indicated on the "development cost" sheets making the deduction for cost on the "special work order" cost record
- 3 Credit the sums of all development costs applied to production during the accounting period to Unabsorbed Development Cost
- 4 Credit the costs of development on discontinued parts and assemblies to Unabsorbed Development Cost, charging Obsolescence account with a like amount
- 5 Show the unabsorbed balance as deferred item on the balance sheet
- 6 Make a periodical (not exceeding three months) check up of all balances on the "special work order" cost sheet to insure against carrying in the balance of the Unabsorbed Development Cost account amounts covering items that are no longer used in regular production

**Expense Method**—Those companies wishing to charge all development cost accruing in the current accounting period to expense should

- 1 Charge all current development costs to Development Cost account
- 2 Apply development costs to production as shipped on the basis indicated on the "development cost" sheets, making the deduction for costs on the "special work order" cost record
- 3 Credit the sums of all development costs applied to production during the accounting period to Development Cost account
- 4 Credit the costs of development on discontinued parts and assemblies to Development Cost charging Obsolescence account with a like amount
- 5 Close Development Cost account into Profit and Loss

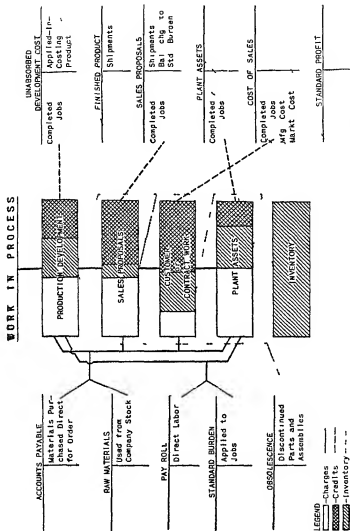


FIG 4 Flow of Accounts for Development Cost (Deferred Method)

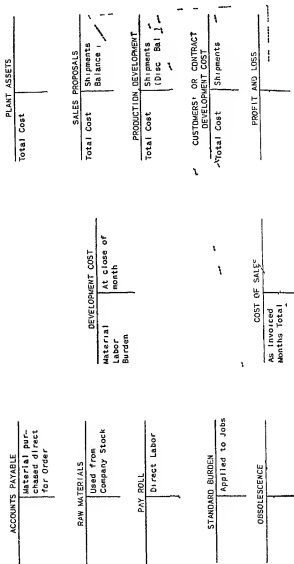


FIG 5 Flow of Accounts for Development Cost (Expense Method)

The Manual also recommends issuance of one work order at the beginning of each accounting period for each class of production development work. All labor and burden is charged to the blanket order.

**EXPENSE LIQUIDATION BY PRODUCT CLASSES**—Where a plant manufactures numerous products, development costs are often absorbed by setting separate rates for each class of product. The method followed by a manufacturer of electrical equipment is described by Papenfuth as follows (N A C A Bulletin, vol 22)

We classify our development expenses under two general heads (1) class of expenditure (i.e. drafting labor experimental labor royalty and legal expense patent depreciation etc.) and (2) class of product of which there are approximately twenty-five subdivisions. In a report prepared monthly (Fig. 6) the expense thus accumulated by class of product to which it applies is shown for the current month and the current year to date. Liquidations of development expense by class of product are at specified liquidation rates applied to and added to the factory cost of sales billed by classes. The details of liquidation by product classes are shown on the back of this report. In establishing these liquidation rates there are a number of conditions that govern such as the amount expended for development anticipated sales and what the traffic will bear. The success of the development project can only be determined as time passes. In any case by accumulating development expenditures by product classification and liquidating this expense as merchandise is sold we are able to determine the degree of success of individual development projects. Even though it may be true that the strong will carry the weak the situation is at least disclosed and accordingly kept in hand better by having this information available.

A recent government bulletin issued to clarify Treasury Decision 5000 with respect to war contracts approves this method.

With respect to engineering and development expenses the absorption rates are sometimes founded upon a percentage of sales, but inasmuch as the application of these expenses may vary between different classes of products it is commonly the practice to establish standard percentages for each product class which percentages may be expressed in terms of total manufacturing cost as the base.

According to Kemp (N A C A Bulletin, vol 4), expenses incurred in research and development work are charged to an appropriate ledger account and carried as a deferred asset to be liquidated into manufacturing costs.

In addition to the controlling account there should be as many subaccounts as there are lines of product. In fact a line of product may be further subdivided into types and sizes. The extent to which this subdivision is carried is a matter to be determined by each manufacturer.

Having collected all this class of expenses into a Development account under proper subaccounts for each line of product we have thereby kept out of our overhead expenses a very large sum which under older methods of accounting would have been distributed over the entire product upon the same percentage basis as the other overhead expenses.

Furthermore having collected these expenses in this manner, we are not only able to liquidate them directly against the specific line of product on account of which they are incurred but to liquidate each account within whatever period of time may be decided upon.



PLAINVILLE & LUDLOW PLANTS		Month of _____ 19__		
SUMMARY	This Month ____ Weeks	Last Month ____ Weeks	Y to Date	
			This Year ____ Weeks	Last Year ____ Weeks
<u>A A F Ch gr</u> M 1 Tool Expense M 2 Patent Deprec. M 3 Drafting M 4 Engineering M 5 Royalty and Legal Expense M 6 Miscellaneous Expense M 7 Field Service  Total Charges				
<u>A A F fig id li</u>				
<u>U l g M i d B i</u> For Period (O w l g s d t d in Red)				
Factory Cost of Sales and Ratios				
Factory Cost of Sales (Not Inc A A E)  <u>Net A A F i y C i f Sale</u> Total A A E Charges Total A A E Liquidations				
Budget and Realization of Charges				
	This Month ____ Weeks	This Year ____ Weeks		
	Budget	Over or Under	Budget	Over or Under
<u>Budget A A E C i a</u> M 1 Tool Expense M 2 Patent Deprec. M 3 Drafting M 4 Engineering M 5 Royalty and Legal Expense M 6 Miscellaneous Expense M 7 Field Service  Total Budget				

FIG 6 Applied Apparatus Expense

## ULTIMATE CHARGES TO PROFIT AND LOSS FOR DIFFERENT TYPES OF RESEARCH COSTS

Type of Cost	Manufacturing Cost		Total to Manufacturing Cost	Profit and Loss			Total to Profit and Loss	Treatment Varies	No Answer
	Applicable to All Production	Applicable to Product or Line Benefited		Administrative Expense	Selling Expense	Research Cost as a Separate Profit and Loss Item			
Development of New Product	40	21	61	7	2	24	33	4	3
Improvement of Present Product	49	19	68	5	2	20	27	3	8
Development of New Manufacturing Methods	63	14	77	4		14	18	3	3
Development of New and Special Machinery	41	18	59	2	2	5	9	4	34
Pure Research	34	7	41	13	2	28	42	5	18
Cost of Purchased Patents	13	13	26	22	1	9	33	2	47
Royalties on Manufacture of Patented Products	10	47	57	10	1	9	20	2	27
Patent Litigation Expense	10	7	17	56	1	7	64		25
Experimental Testing of Products	59	29	79	3	1	12	18	4	5
Testing of Raw Material	69	16	85	3		3	10	2	9

Fig 7 Final Disposition of Research Costs in Profit and Loss Statement

The latter is accomplished by spreading the development cost over the estimated production over a specified period of time. If at the end of that time there is an unabsorbed balance, the latter is disposed of by charging the unliquidated amount directly to Profit and Loss or to a reserve account previously set up for that purpose. In this way all unliquidated development expense is kept out of manufacturing costs.

**FINAL DISPOSITION IN ACCOUNTS**—The revenue basis under which research and development costs are charged off currently, includes costs charged to Profit and Loss during the period when incurred as well as those which may be charged to product cost and hence temporarily capitalized in inventories of work in process and finished goods. A section of the NACA report classifies these charges in terms of their final disposition in the accounts on the basis of

- 1 Inventory charges
- 2 Profit and loss charges
- 3 Subdivision of profit and loss statement where the charge is shown

Even for deferred or capitalized expenditures the cost is ultimately absorbed in Profit and Loss through depreciation or amortization charges. Fig. 7 presents data relating to the ultimate treatment of research and development costs whether originally capitalized or charged off at the time incurred.

Research and development costs may be added to product costs either as a part of general overhead applicable to all production, or by being included as an overhead or in some cases as a direct cost of the particular product or line benefited.

Again, costs may be charged off currently as incurred by inclusion in administrative expense or selling expense or by being shown as a separate deduction from Profit and Loss wherever the size and importance of the items justify separate presentation. Some of the different types of research and the extent to which the various accounting treatments are applied to them are discussed below.

**Development of New Products**—This includes all research costs whether a product is actually introduced or not. If no new product is developed, it would be impossible to charge it to product cost. About 60% of the companies investigated charge research costs on new products to manufacturing expenses. The general attitude is that production as a whole is benefited by product research and that the cost should be borne by all lines. There are companies, however, where product lines are distinct, and hence it is feasible to charge each line with the research work carried on in its behalf. A few companies are able to apply such research cost as direct costs of products or lines of products instead of including such expenditures in product overhead. Of the companies which charge new product research to current Profit and Loss, a large proportion report the expenditure (usually with other types of research and development costs) on the profit and loss statement under a separate heading as research costs. In the case of these companies, such expenditures are written off currently, more because of a feeling that they should not be included in inventory values than because of any feeling that they represent administrative or selling expenses.

**Improvement of Present Products**—Industry apparently follows the same general pattern here as in the development of a new product but with a somewhat greater inclination to charge research costs to manufacturing expenses. A larger proportion of reporting companies treat research on present products as proper additions to product costs and inventory values than is the case for research on new products. Fewer companies apply the cost of improving present products as a charge to the product or line benefited than in the case where new products are developed. This runs counter to expectations, for the costs of improving an existing product might appear to be a proper charge against that product or line rather than a charge against all production. An explanation may be that in many cases there is no more assurance of success in research work on improving products than in research work aiming at the discovery of new products. Where research activities are carried on continuously, and it is believed that such work is necessary to retain the company's place in the industry, there appears to be justification for treating this continuing expenditure as general rather than product overhead. However some companies follow the practice of charging the costs of continuing research on both new and present products directly to Profit and Loss, preferably as a separate item. This treatment avoids the debatable policy of impounding any of such costs in inventories of work in process and finished goods.

**Development of New Manufacturing Methods**—Approximately four-fifths of the reporting companies charging research costs for developing new manufacturing methods as overhead include this item in cost of product manufactured. Since such projects are usually undertaken to reduce production costs or increase manufacturing efficiency it is logical that such costs should be charged against manufacturing division. Furthermore it appears reasonable to make this charge through general overhead, since in the majority of cases the processes and methods developed are joint facilities serving all or at least several lines of product.

**Pure Research**—By pure research is meant that type of research work which is not ducted toward the solution of a specific problem, the immediate development of new products, or the improvement of production methods, but is concerned with discovering fundamental scientific facts which may later be utilized for any of the practical ends previously mentioned. Experiments carried on in the laboratories of General Electric Co., Westinghouse and Bell Laboratories illustrate this type of research. Thus the NACA report, cited earlier, states:

It is a little surprising to find that even in the case of pure research where no immediate benefit to production is expected to occur, almost as many companies include the cost in general or product overhead and charge it off currently to Profit and Loss. It is difficult to see how pure research can properly be charged as a cost of a particular product line except in the case where such cost has been deferred until the fundamental discovery has been used in the development or improvement of products, methods or equipment. But none of the reporting companies capitalizes this type of expense. One must assume then that the charge to product overhead is based on expected future benefits. It seems pertinent to ask whether such expenditures are proper components of values to be used for the goods in process and finished goods inventories.

**RESEARCH UNDER GOVERNMENT CONTRACTS**—The status of research work in relation to government contracts is covered in Treasury Decision 5000, which makes provision for development and experimental expense on Navy and Army contracts. Section 269(d) provides

In case experimental and development costs have been properly deferred or capitalized and are amortized in accordance with a reasonably consistent plan, a proper portion of the current charge determined by a ratable allocation which is reasonable in consideration of the pertinent facts may be treated as a cost of performing the contract or subcontract. In the case of general experimental and development expenses which are charged off currently a reasonable portion thereof may be allocated to the cost of performing the contract or subcontract. If a special experimental or development project is carried on in pursuance of a contract or in anticipation of a contract which is later entered into and the expense is not treated as a part of general experimental and development expenses or is not otherwise allowed as a cost of performing the contract, there clearly appearing no reasonable prospect of an additional contract for the type of article involved the entire cost of such project may be allowed as a part of the cost of performing the contract.

This is further explained in a special bulletin issued by the Army and Navy Departments (Explanation of Principles for Determination of Costs under Government Contracts).

The distinction has previously been made between engineering services related immediately to manufacturing operations (shop engineering expense) and research, experimental, and development costs not related to current manufacture but devoted to future improvement in and application of products. The cost of the latter research and experimental development work may be absorbed in manufacturing cost on a regular basis by means of absorption rates, on the principle that these activities are usually maintained under a consistent program independently and apart from current manufacturing operations and that their benefit relates to products on a uniform scale over a period of years more properly than according to actual expenditures in any given year. When these costs are deferred or capitalized in conformity with a consistent plan, reasonable allocation may be treated as a cost of performing a contract.

Alternately, when it is the policy to charge off actual research experimental and development expenses currently in each year rather than to use stabilized absorption rates a reasonable portion thereof may be allocated to the cost of performing the contract.

## Problems of Capitalizing Research Costs

**REASONS FOR FAILURE TO CAPITALIZE**—Business attitude shows a general reluctance to capitalize research costs. Among the reasons are

- 1 That charging them off currently is conservative
- 2 Results of research work are always uncertain hence, if work should represent failure no future period would benefit
- 3 Literature on this subject has not been very extensive or specific on the thin line of distinction between those costs which may be capitalized and those which are charged currently to expense

This is due to the fact that research projects differ widely, one from another, and other attendant circumstances also vary widely. Doubtful

cases must in the nature of things be left to the informed judgment of those closest to a project

**Factors in Capitalization**—Capitalization of different types of development expenses depends on a number of modifying factors. Some companies absorb the cost of research projects currently if of normal size, but large expenditures which might distort current costs if included are capitalized or deferred. Others absorb currently the costs of projects which benefit the entire line or plant, while those benefiting a single product group of products, department, or process are deferred and applied as costs of the product or process benefited. The largest group absorbs the cost of research work carried on as a continuous function absorbed in current expense, while the costs of special projects, if successful, are capitalized.

The above statements agree with the findings in the U S Chamber of Commerce report, cited earlier. It states that most reporting companies charge the costs of research projects, whether successful or unsuccessful, to costs of operations for the current period. In some companies research costs are charged against particular classes of products for which the research work was done, while a few companies capitalize the costs of successful projects. The report quotes one company making paper products, as follows:

In the case of a completed project which yields a tangible beneficial result the cost of the project is considered as a capitalizable expense and is amortized on the basis of the estimated or definitely established benefit of the result. For example where a patent has resulted the cost of the project may be amortized on the basis of the life of the patent or, in the case of a definite savings accomplished, the cost may be written off at the rate of the savings per year similarly where a unit of machinery is the result the cost may be capitalized as a part of the cost of the machinery and written off as regular depreciation of equipment.

Where a project is abandoned as valueless the cost of the project is written off as current research expense.

Where a project is temporarily abandoned due to priority importance of other projects the accrued cost is classified as deferred expense and its final disposition determined upon the ultimate result of the completed project.

Another company manufacturing electrical wires and cables charges the research cost of a project which results successfully to product cost over a definite number of parts manufactured usually not over three years, as development expense. Where a project is abandoned, the cost is charged to **General Development Expense**, which in turn becomes a cost of operation by monthly charges throughout the year.

A third company making electrical machinery disposes of the costs of research as follows:

1 Projects which, if successful will directly benefit some specific engineering department or associated company. For such projects an appropriation is requested from the department or company concerned and if granted, is included in their engineering budget. The cost of the work is billed monthly.

2 Projects of a general nature not allocable to specific apparatus lines but of interest to all departments. For such projects an appropriation is requested from department and the cost which is billed monthly to that department, is prorated over all designing engineering depart

ments as part of the company's engineering overhead Example General studies of alloys

3 Projects of so fundamental a nature or aiming at the development of so new a device that they are of no immediate interest to any other department These are carried on laboratory accounts and appear in no budget other than our own If successful, and taken over by some other department, they are liquidated, if possible, either by payment of a lump sum or by "development credits" handled like royalties paid by that other department and charged to factory cost In the latter case payments may continue after full liquidation so that successful projects may pay, in part for unsuccessful ones Examples of such projects studies of arcs at high pressure studies of surface films development of a new type of insulation etc

In some branches of the chemical industry, "pilot plants" are used before production is commenced on a large scale One company says

All research in the laboratory stage is written off currently each month as expense If a project gets to the pilot plant stage, then such development costs are deferred and absorbed when the project or product gets into production If it fails after it leaves the laboratory stage it is absorbed in expense as quickly thereafter as consistent This of course, must be watched very closely and not allow an unreasonably high deferred charge to exist

Our experience is that it is unwise ordinarily, to defer writing off research charges in the early stages of any project for the reason that many times these investigations cover a rather long period and if the venture is not successful you are confronted with a sizable expenditure to be written off and if it is successful, it becomes quite a burden on the new venture

One company manufacturing rubber products makes the following comment under this heading in explanation of why it is impossible to charge research costs to the products involved

In addition to specific projects, where a definite return is possible we plan a certain amount of fundamental research to act as a stimulus for the whole department and to attract and hold men of purely scientific bent

#### **DISTINCTION BETWEEN CAPITAL AND REVENUE—**

The essential problem in dealing with research costs is the distinction between asset and expense Those costs which can legitimately be classed as assets are properly carried on the balance sheet and liquidated over their expected useful life Those costs whose favorable influence on future revenues is problematical, at best should presumably be written off during the period when incurred or as soon as their significance for future revenue has been adjudged negligible

In the development of a new product or improvement of an existing product costs are incurred in the hope that future product costs are lowered or earnings increased However, opinion varies as to whether this is a proper test for capitalizing Thus, Paton and Littleton (Introduction to Corporate Accounting Standards) state

It is sometimes assumed that no expenditures may be capitalized (that is, deferred) unless an increase in the volume of revenue or decrease in the cost per revenue unit may be expected to appear as a result This position is untenable Not infrequently additional investment in plant facilities is required when there is no prospect of either an expansion of revenue or a reduction of operating costs In working the lower levels of a mine for

example, it may be necessary, in order to continue operations to install equipment not needed at earlier stages of the process of extraction. To refer again to the general test all costs prudently incurred which can be reasonably associated with future production are subject to deferment. Needless to say no additional investment should be made unless the available data indicate that the enterprise will be advantaged thereby—will be in a more favorable condition than would be the case if the proposed charges were not incurred.

From any point of view, the resulting value of research is intangible, and is therefore accorded the same conservative treatment as all intangibles. The tests to be applied are stated by Paton and Littleton as follows:

The general test or tests to be applied to the various costs incurred in the particular period to determine their disposition as deductions from current revenue on the one hand and deferred charges on the other may be readily indicated. First does the charge in question represent a bona fide cost an expenditure reasonably justified under all the circumstances? If the answer is in the affirmative the charge cannot well be treated as a loss, although it may still be a current deduction. Second does the charge represent a factor from which a future benefit or contribution can reasonably be anticipated? That is is the charge intrinsically associated with future revenues? If the answer is again in the affirmative the cost under consideration may be properly deferred. A minor test of some value is suggested by the question. Is the charge of the regularly and frequently recurring type? For costs of this nature there is a presumption in favor of absorption in current operations, due allowance being made for ordinary inventories and prepaid balances.

**Maintenance of Competitive Position**—In the case where search for a new or improved product has been successful the costs are appropriately capitalized and liquidated over the period during which the new or improved product will be sold. Yet in a highly competitive field in which every producer is doing his best to improve his existing product or perfect new ones the cost of such work may merely result in the maintenance of a concern's same relative position in the field. Costs that merely prevent degeneration of one's competitive position cannot often be justified as assets. Practical as well as theoretical considerations seem to indicate that these costs had best be treated as current expenses.

**Increased Earning Capacity**—If sufficient evidence is available or the preponderant judgment of qualified observers is that new or improved products enable an organization to forge definitely ahead in terms of earnings it may be appropriate to defer or to capitalize the costs of research. The mere probability of increased earnings in the near future, however, is not adequate evidence that such expected increase in earnings is attributable to this particular intangible research cost. All companies in the field may be expected to experience increased income due to a cyclical rise in business. In other words capitalization must rest on the rather clear but quite unproven grounds that the expected increase in earnings is attributable to the influence of the new or improved product.

Again, a new product may have been perfected or an existing one improved but at a greater cost than the expected increased earnings would justify. Under such circumstances, only a "reasonable" amount



should be capitalized and the remainder be charged as a current expense. All these uncertainties and other circumstances surrounding product research have led business men and accountants to charge off to current expense more often than to defer or capitalize research and development expenses.

**EXTENT OF CAPITALIZATION**—Reference to the table (page 1142) indicates the extent to which capitalization of each type of research and development expenses exists in industry. Concerning the development of new products and the improvement of existing product, existing practice indicates the conservatism of business men in the face of all the uncertainties involved in research costs. Yet fundamentally it is just as possible to make a bad or a good investment in buildings or equipment as it is in research work. The intangible nature of the results makes an easy solution impossible. The same holds true in the development of new manufacturing methods where the achievements of research in this field are reflected in lower costs or superior products. The difficulty of assigning any separate value to the integration of the parts of an organization or to the efficiency with which a manufacturing or other process may be carried on presents an almost insuperable obstacle to capitalizing such costs. In addition new manufacturing methods have a habit of becoming fairly widely known within a comparatively short period of time. The advantages of the pioneer of these new methods are thus relatively short-lived. As soon as knowledge of newer methods becomes at all widespread, the value of such methods tends to disappear.

In connection with the development of new and special machinery, a recent NACA study shows that a majority capitalize this item, though practice varies considerably. Some comments are as follows (NACA Bulletin vol 20):

'Capitalized when judged successful at fair replacement value balance to overhead'

"Normal value capitalized excess expense charged to overhead"

"Cost of building a duplicate machine is capitalized balance of cost expensed"

"Machines to be used as fixed assets in our factories are capitalized at an appraised value balance of cost being charged off as a development expense"

"Time in experimental department charged to expense but when it gets to our special machine or toolroom departments these charges are capitalized"

The inference from these comments is that it is the normal cost of manufacturing new machines which is capitalized and that in the majority of cases the strictly research and development costs connected with the new machine are absorbed in current costs.

Here again there appears to be little question as to the complete propriety of capitalizing the costs of construction of new and special machines yet the costs of experimental work that was necessary to the design of machines are treated as current expenses in a majority of cases. It is not considered orthodox accounting to carry machines at an asset value greater than cost to make, yet if the job had been given in

the beginning to a firm or company of engineering specialists the cost of the machines must include the preliminary work of research, design, and experimental work as well as the actual cost of manufacture. Businessmen and accountants have taken the conservative position but a fairly clear case can be made for capitalizing the entire amount, or at least such part of it as does not seem excessive or out of reason. In part the feeling is that the advantage of the new technique is in many instances transitory, since other concerns quickly make similar or comparable improvements, therefore the time over which these costs are liquidated is so short as to make capitalization or deferment unwise or unnecessary. It might be plausibly argued that research costs as such would have to be liquidated over a shorter period of time than the machine itself since the special advantage of the machine would be lost before its ordinary serviceability would have been depreciated.

**SUCCESSFUL AND UNSUCCESSFUL RESEARCH**—Presumably all costs are assigned to products or lines receiving the benefit if any reasonable basis of allocation can be found. If research and experimental work are entirely successful and can be capitalized, the costs can be allocated without too great difficulty. If, however, the experimental work is unsuccessful and all costs are charged to current operations the assignment of total research costs for such projects to the costs of the product for the current year raises the question of cost distortions. This is not too serious if the same amount is spent each year for research on a particular product. When however, a project is undertaken only occasionally, the difficulty becomes greater especially if any significance is attached to the comparative relationships of the annual or monthly succession of costs per unit. It is this difficulty that has given rise to the rather common treatment of research as a general expense to be carried as a separate charge to Profit and Loss or if charged to manufacturing expense, it becomes a part of general overhead.

**Cost of Failures**—The current practice is almost unanimous in charging to current Profit and Loss the costs of research and experimental work which does not achieve immediately usable results. This is undoubtedly conservative practice. But it is inevitable that in pioneering work every project is not successful. On the average the favorable results compensate for failures, otherwise the whole program has been unwisely undertaken or continued. In many instances experimental work may be carried on over two or more fiscal periods before its final results can be evaluated. Some failures are almost inevitable in the series. Some enterprises spread the total research cost over the estimated value of the successful developments, thus making detailed records unnecessary. The propriety of capitalizing the value of the good ones with the total costs including the costs of the unsuccessful ones depends in part on the precise circumstances in an individual case. Where research toward a particular objective is rather long and complex, the costs may reasonably be deferred. Concerning this point, Paton and Littleton, cited earlier, state

Particular expenditures made in acquiring and developing property often appear to have been unproductive when considered individually. Yet they must be treated as valid costs incurred when viewed in the light of the entire situation. Thus, the drilling of one or more dry holes in the

development of a tract of oil land may be unavoidable and may represent a proper and significant element in the entire process of development in this event the cost of such drilling should be treated as a cost of property (and ultimately of revenue) rather than a loss. It does not at all follow however that ill advised costs should be reported as invested in property or that costs of reasonable commitments may be retained in the property account after it becomes clear that the outcome will not be successful. No cost factor of any kind should be held on the books as a charge to future revenue when there is decisive objective evidence of the termination of significance.

Hence the objectives must be clearly visualized and not too narrowly interpreted. Excessive conservatism can give rise to balance sheet values quite as distorted as undue optimism. Kester (Advanced Accounting) makes a similar point concerning patents developed within the plant.

When the patent is not purchased from outside but is developed within the plant itself only the costs of developing and securing the patent are proper charges to the asset as constituting its value. In many concerns an experimental laboratory is maintained for the purpose of working out improved methods and devices. Much of the work of such a laboratory is often fruitless so far as patentable devices are concerned but the portion of the cost of the work clearly allocable to such patents as are developed should be charged as costs of those patents. If the work of such a laboratory is devoted exclusively to the development of patents then a strong case can be made for the argument that the entire cost becomes a proper charge to whatever patents result from the effort.

This general statement is tempered by the comment that

It is undoubtedly sound policy to charge against revenues the costs of abandoned projects and to carry forward as assets those projects in process which give good promise of ultimate fruition or which have been developed so slightly as to give no basis for judgment to outcome.

In short research costs may be deferred if there is clear evidence that its benefits will extend to future operations. Such evidence is often difficult to obtain. It seems to be widely accepted that this would apply to successful experimental work. Where no clear cut results are obtained most authorities would recommend that it be charged to current operations. There are modifying conditions which may apply to certain cases. Where a few failures are to be expected in a long sequence of research projects directed toward a rather definite goal, it may be argued that if the venture as a whole is successful, the costs allocable to failures in the series may be capitalized as a part of cost of successful episodes. This would be restricted by most authorities to those cases where experimental projects were so interconnected as to form a unit when taken together.

In pure research the objectives are broader and less closely directed to a given goal. The results if successful may or may not be of any immediate use in developing a company's products. It does have prestige value however and may contribute generously to the creation of valuable goodwill. Goodwill of that sort, however, is almost never given recognition in the accounts. In pure research, the ability to assign the costs of research to products which may be developed by additional and more specific research is very difficult. One project in pure research may conceivably give rise to a whole series of new products hence the

apportionment of the cost of pure research is almost impossible except on a purely arbitrary basis. Furthermore, the results of pure research may remain apparently valueless for several years until later research may disclose their usefulness. Since pure research is basic in nature, this is very likely to be true. This time lag and the impossibility in many cases of perceiving the true value of the results are not conducive to capitalization. Such uncertainties are not desirable characteristics of assets.

**RESEARCH COSTS AND INTANGIBLES**—Research and the results of research involve intangible factors. Yang (Goodwill and Other Intangibles) has given a very useful summary statement in this connection of the problem of intangibles in general:

It is often thought that goodwill and patents invariably possess some value regardless of their influence on the operation of the business, whereas in reality they are valuable only so long as and to the extent that they are not similarly possessed by every field of business. To a certain extent both of these are presumed to exist in every business and it is only when they exist in an amount greater than what is accessible to a normal competitor that they come to possess an effective importance for the business entrepreneur. Likewise in the case of a monopoly right such as a patent it is evident that in order to have value the patent must actually be such as to enable its owner to derive an advantage by reason of its possession. As a corollary to the above it may be mentioned in this connection that a right or property belongs to the category of intangible assets only as long as it remains a source of differential or monopoly advantage. When the right or condition becomes an item of necessary cost for the operation of business, i.e. when it becomes by virtue of industrial development or change of legal policy a common adjunct of an ordinary business, it ceases to be an intangible asset.

Hence it is seen that value of intangibles bears no definite relation to the cost of their development. This is natural in view of their differential and monopolistic character. If advantage could be created by cost directly it would before long cease to be an advantage. Yang further points out that a concern with large appropriations for research laboratories ordinarily secures a relatively larger number of inventions, but it is not uncommon to find large sums of money spent without a single noteworthy accomplishment in this direction and in such cases it is quite misleading to base property values of the business directly on the amount of annual appropriations. The fact is that success in the development of intangibles depends primarily on personal skill and only indirectly on the means or resources available. Personal skill may be reinforced and rendered more effective through the development of facilities for research and experimentation but the amount of the expenditure on this account is no reliable measure of the results that ensue in an individual case.

**APPRAISAL VALUE**—It is characteristic of research that the value of the result is uncertain, and may or may not have consequences commensurate with the outlays. This necessitates appraisals of the value of the results. It appears to be the general rule that assets should not be included in a balance sheet at the time of acquisition at a cost greater than the cost price reached by unrestricted negotiations between independent parties. Where such an objective cost is not available, the

closest approximation to it is the most suitable. A research project whose cost is more than its current market value (or a careful approximation of it) should be capitalized or deferred only to the extent of its fair market value, the remainder is charged to Profit and Loss of the current year. When on the contrary, results were very valuable and achieved at low cost, it would theoretically be appropriate to include them as assets at appraised value. Paton and Littleton write (Introduction to Corporate Accounting Standards)

In extreme situations of this type it may be necessary to establish formally a new point of departure on the basis of implied cash cost the amount of money which would unquestionably be necessary to acquire the resource in its established commercial status in lieu of an actual bargain price. There is no variant in this suggestion it should be emphasized for writing up assets to new levels on the basis of mere hopes and expectations or for opening the records to estimates not supported by conclusive evidence. It is purely a question of establishing a dependable starting point for resources having a clear cut commercial value that have been acquired under extraordinary conditions.

The NACA survey, cited earlier, shows that about 40% of the companies capitalize appraisal value when less than cost. It also appears that even in successful developments the amount capitalized in many cases is not the full amount of the expenditure for development, but a smaller, more conservative figure based on an appraisal of the value of the development. Use of appraisal value in some cases can be described as a means of separating development cost from manufacturing cost, so that manufacturing cost may be capitalized and development cost written off.

**RESEARCH COSTS AND TAXATION**—In general it appears that the distinction between capital and revenue expenditures for tax purposes closely parallels that followed in good accounting practice. Tax officials and courts are hesitant to attempt a general definition of this differentiation. In the American Seating Co. case (4 B.T.A. 649) it is stated that

In the ordinary conduct of a manufacturing business the differentiation of capital expenditures and operating expense disbursements is largely a matter of sound discretion and experienced business judgment. The dividing line between the two classes cannot be defined by statute and so far as has come to our attention no court has ever yet attempted to make a definition that can apply to any case except the one under review.

In a long series of decisions the Board of Tax Appeals has held that costs of developing patents, secret processes, formulae, etc., are capital expenditures and cannot be deducted as ordinary and necessary business expenses (Gillham Mfg. Co., 1 B.T.A. 967, Goodell-Pratt Co., 3 B.T.A. 30, Beaumont Co., 3 B.T.A. 822, John F. Canning, 29 B.T.A. 99, Claude Neon Lights, Inc., 35 B.T.A. 424). These costs are subject to depreciation when the period of usefulness of the asset may be estimated from experience with reasonable accuracy.

When it can be established that research costs have been completely unsuccessful and tests of failure can be sustained during the fiscal period in which expenditures have been made, the expenditures are deductible from gross income (H. L. Strong, 14 B.T.A. 902). When, however, it

is not immediately apparent that the results are without value, the presumption is that research costs will be treated as capital expenditures. If at a later time it is established to the satisfaction of the Commissioner that the results of such expenditures are without value, a loss may be claimed (Angier, 17 B T A 1081, Perine et al 22 B T A 201, Acme Products Co, Inc, 24 B T A 194, Dresser Mfg Co, 40 B T A 341 )



## SECTION 22

### PLANT ASSETS AND DEPRECIATION

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## SECTION 22

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### PLANT ASSETS AND DEPRECIATION

#### Basic Considerations and Definitions

**IMPORTANCE OF PLANT ACCOUNTING**—Fixed plant accounting includes two subjects of prime importance

- 1 Plant asset record keeping
- 2 Depreciation accounting

These represent the joint care of the cost accountant, the engineer, and the general accountant. The cost accountant must have sufficient familiarity with both these subjects, even though he is not personally concerned with keeping the records. In general, the engineer is concerned with estimating the life of the asset, the rate of obsolescence, and its maintenance. The general accounting department is among other things, concerned with the keeping of the plant records. From the point of view of cost accounting, the above subjects assume direct importance, first, because some plant expenses are distributed on the basis of property values in the different departments and, secondly, because depreciation and the allied obsolescence of plant property and equipment used in manufacturing is an element in the cost of production. The information required to carry out these objectives is found in the property records.

The material presented in this section is tempered to meet the needs of the cost accountant in his day-by-day work in his relations to the plant engineer and the general accountant. A complete discussion of all aspects of depreciation accounting may be found in Section 13 of the Accountants' Handbook (3rd Ed.), William A. Paton, Editor. Some passages of the material in this section are taken directly from that source, some are paraphrased, some amplified, but in general the material is adapted to the needs of the cost accountant.

Modern mass production requires the tying up of large amounts of capital in fixed assets. Avery (Accounting for Depreciable Fixed Assets) presents a table showing percentages of total assets represented by fixed plant property for fourteen selected groups. This table shows a range of from 27% for slaughtering and meat packing to 85% for utilities. Hossack presents a similar table (N.A.C.A. Year Book, 1936) for ten anonymous companies chosen at random. The percentage of net capital assets to total assets varies from a low of 30% to a high of 75% (Fig. 1).

Kind of Company	Total Assets	Net Property Account	% Net to Total
Heavy machinery manufacturer	\$ 71 542 000	\$ 28 035 000	40.4
Meat packing	353 802 000	172 937 000	48.9
Oil company	159 597 000	97 083 000	60.8
Steel producer	674 046,000	504 419 000	74.8
Steel producer	2,142 082,000	1 605 119 000	75.0
Tractor manufacturer	44 338 000	17 654 000	39.8
Automobile manufacturer	1,179 425,000	354 220 000	30.1
Automobile manufacturer	60 379,000	25 517 000	42.2
Rubber company	202 631,000	87 423 000	43.1
Food products	207 072 000	110 228 000	53.1
Averages			51.1

FIG 1 Fixed Property Investment (averages for 1930 to 1935)

**TYPES OF EXPENDITURES**—Church (Manufacturing Costs and Accounts) classifies expenditures for purchases into three groups from a costing viewpoint, namely

- 1 Purchases chargeable immediately to production such as labor rent, and taxes
- 2 Purchases chargeable eventually, but not immediately Raw materials and supplies are examples of this
- 3 Purchases chargeable only by periodic instalments

The first group represents values measured chiefly by time and must necessarily be consumed within the time limit, or the payment has no economic value. In the second group materials and supplies are purchased in bulk and kept as inventory until consumed in production. The last group includes purchases whose value diminishes slowly, by periodic charges for depreciation included in the cost of production. Within this class belongs all capital investment, such as buildings, machinery, equipment tools. Each of these differs in its rate of diminishing value and thus each may be charged to cost at a different rate.

**TERMINOLOGY**—Published balance sheets vary greatly as to the designation and classification of fixed assets. Attempts have been made by trade associations and others to establish standard terminology. The following definitions are intended as a guide in setting up the factory's glossary, and may be modified or condensed to suit local conditions.

**Plant**—According to accounting terminology, plant is a broad term which includes land, buildings, machinery, equipment, furniture, etc. However, Paton (Advanced Accounting) limits the term to structures and to equipment, thus excluding land. Hence it would seem that in its widest sense, plant is synonymous with fixed assets. Even with land excluded, it is still equivalent to the common designation "buildings and equipment."

**Equipment**—This covers the machinery, tools, furnaces, apparatus, and appliances used in carrying on the industrial process.

**Fixed Assets**—This is a general term covering all those physical facilities necessary for the conduct of the business. They represent, in the language of the economist, the durable producers' goods, that is,

the capital assets of a business required to create a product for sale. According to Taylor & Miller (Intermediate Accounting) they cover

those assets which are acquired with the intention of retaining them for use throughout their normal life. They are not purchased for resale. It is their use and the services they render in connection with the conduct of regular operations of the business that determine their proper classification as fixed assets.

**Additions**—By additions is usually meant, in the case of buildings and other structures, new and separate units and extensions of existing units. A new building is clearly an addition to property, likewise the erection of a new wing or other extension commonly rates as an addition. In the case of equipment, similarly, additions represent new and distinct units, or extensions such as frequently arise in connection with such assets as water mains, power lines, etc.

**Improvements or Betterments**—The usual definition of improvements has an engineering basis. That is, by an improvement is generally meant an alteration or structural change in a building or unit of equipment which results in a better piece of property in the sense of greater durability or increased productivity or efficiency. For example, the replacement of a shingle roof on a building by a slate or metal roof would be deemed an improvement. The replacement of an entire unit by a more up-to-date and efficient type of asset is also often referred to as an improvement.

Newlove, Smith, and White (Intermediate Accounting) define betterments as "a replacement of an existing asset or unit of an existing asset by an improved or superior part or unit." These authorities add, "Usually the betterment results not only in an increased cost valuation of the asset but also in a more productive, more efficient, or longer-lived property."

**Renewals**—Marston and Agg (Engineering Valuation) define renewals of physical units of industrial property as their replacements at retirement by substantially duplicate units.

**Replacements**—Ordinarily, replacements are capital expenditures, the term being used as a synonym for renewals, that is, a substitution of one asset by a new one of substantially the same capacity. Bulletin F of the Bureau of Internal Revenue advises the following treatment:

As a practical matter, it is permissible to charge the cost of rehabilitations or small replacements directly to the depreciation reserve leaving the capital account undisturbed provided there has been no material change in price levels and no substantial improvement in the new equipment. Replacements in the nature of betterments, however, should always be added to the depreciable asset account.

**Repairs**—Bulletin F, cited above, defines repairs as

disbursements which neither materially add to the value of the property nor appreciably prolong its life but merely keep it in an ordinarily efficient operating condition.

## Control of Capital Assets

**METHODS OF ACQUISITION**—Upon organization of a new business, it is usually necessary to acquire certain assets before others. Factories require sites, buildings, machinery, furniture etc., while retailing or wholesale concerns need warehousing, showrooms and delivery facilities before merchandise inventories are required. Taylor and Miller (Intermediate Accounting) list the more common methods of acquisition of these necessary facilities:

- 1 By outright purchase
  - a Full cash payment being made at once
  - b Part cash payment down with balance on account evidenced by promissory notes, provided in a so called purchase money mortgage
  - c Full payment being made by issuance of shares of stock
  - d Involving an exchange of other property
- 2 By construction
- 3 By execution of conditional sale contract
- 4 By lease agreement or land contract
- 5 By donation
- 6 By discovery

The cost of assets purchased outright is evidenced by the vendor's invoice at time of acquisition or by the written agreement or contract which was the basis of acquisition. **Transportation charges** and bills for services rendered by all those connected with the delivery and complete installation and preparation of the asset for actual use must be capitalized. The cost of razing old buildings on a newly acquired plant site is charged to the Land account.

Cases occur where the cost of fixed assets built for a concern's own use must be obtained from cost records. The actual cost of materials used, labor costs incurred, and reasonable application of overhead expenses are component parts of the total cost of the assets. No charge for idle time or idle plant capacity may be included and no profit may be realized by a company upon work done for and by itself.

The American Institute of Laundering (Manual for Uniform System of Accounting) gives a list of capitalizable items for the purchase of land and machinery and equipment:

### Cost of Land

- 1 The original purchase price
- 2 Cost of registering title
- 3 Cost of recording fees
- 4 Broker's commission
- 5 Attorney's fees
- 6 Any other cost incidental to purchase

### Power Plant Machinery and Equipment

- 1 The original purchase price
- 2 Freight
- 3 Insurance in transit
- 4 Cartage from railroad terminal to plant
- 5 Installation charges—mechanics, electricians, steam fitters, etc.

**BUDGETING CAPITAL EXPENDITURES**—In a large corporation some coordinated plan or system is necessary to tabulate the

plant needs and construct building and repair programs. These are variously known as the yearly budget, construction program, expansion schedule, repair budget, and maintenance program. Requests for authorization to make expenditures for physical property should give the following information:

- 1 Purpose of the expenditure
- 2 Estimate of cost
- 3 Loss on properties to be retired
- 4 Annual addition to depreciation, taxes, and insurance
- 5 Savings to be effected

One large manufacturer with many operating plants has issued rules of procedure for the yearly building and repair program, in order to control capital asset costs. The following is a summary of the general instructions to all plant superintendents:

Each division is expected to submit a budget on Fig 2 by November 1 of each year. Based on each division's estimate of the extent of its operations for the succeeding calendar year, the budget forecasts the total amount it is called upon to expend during that year. The items included are all major or infrequent repairs, extensions and replacements to plant and equipment for the succeeding year. A specific amount as "Sundries or Miscellaneous" is to be included for items under \$400 and also for those not determinable when the budget is prepared. Items in the budget are classified as follows:

- 1 Necessary, things which have to be done irrespective of the trend of business
- 2 Optional things which may or may not have to be done depending upon the trend of business

When the budget is submitted, approval of specific items of \$1,500 or over is requested on Fig 3. Capital and infrequent repair expenditures not approved when the budget is submitted of \$400 or over must be requested as needed on Fig 3. When expenditures necessary to complete a specific item exceed the approved amount by 5% or more, an additional Fig 3 request must be submitted. The auditor of each division advises his operating department when appropriations are overexpended to the extent of requiring additional on Fig 3.

**Approval**—Appropriations involving an outlay of \$1,500 or more must have the approval of the executive committee or board of directors of the division concerned. Items requiring an outlay of less than \$1,500 may be approved by the president of the division interested.

**Control of Costs**—To state estimated cost of work, construction machinery, or equipment the operating official or superintendent, when possible, must obtain at least three bids for estimating purposes. After the appropriation has been approved, requisition for equipment amounting to more than \$200 and construction to more than \$500 accompanied by the bids are sent to the general purchasing agent. Purchases are made direct or locally as occasion warrants.

**Routing of Forms**—The original and two copies, after approval by the president of the division concerned, are sent to the president of the main division. The original and one copy are returned to the division the original to be for the division president and the copy for the division accounting department. One copy is retained in the main office for the use of the general purchasing agent and the accounting department. When Fig 3 does not require executive authority, one signed copy is sent to the president of the main division and is passed on to the purchasing department.







APPROPRIATION REQUEST												
(Division) _____												
Plant	Date	Approp No Request No Shop Order No										
An appropriation is requested for NOTE—Describe on this page character of work to be done, or equipment to be purchased, detailed estimated cost, reasons therefor estimated saving per ton of product or increase in production which will result. If more space is required use additional sheet.												
Estimated Saving per Ton or increase in production _____												
Estimated Saving (if any) per annum _____												
Time of delivery or completion _____												
Work to be done by Plant _____												
Work or equipment to be contracted for _____												
Estimated life of above _____ years												
State "Yes" or "No" if included in Budget. If included give item number _____												
Give complete details, including summary of Estimated cost _____												
Give description of Building equipment or machine to be demolished or scrapped by reason of above or in case the expenditure is to be charged to reserve give cost accumulated depreciation and net carrying value of item being repaired.												
<table style="width: 100%; border: none;"> <tr> <td style="width: 80%;">Description</td> <td style="width: 20%;">Age</td> </tr> <tr> <td>Equipment or Machine Number</td> <td></td> </tr> <tr> <td>Original Cost</td> <td></td> </tr> <tr> <td>Accumulated Depreciation</td> <td></td> </tr> <tr> <td>Book Value as of</td> <td></td> </tr> </table>			Description	Age	Equipment or Machine Number		Original Cost		Accumulated Depreciation		Book Value as of	
Description	Age											
Equipment or Machine Number												
Original Cost												
Accumulated Depreciation												
Book Value as of												

Fig 3 Appropriation Request

penditures authorized by an appropriation are not permitted after the expiration date, if the work or project contemplated by the appropriation is not completed before the original expiration date, an extension of time must be secured.

In case work has not been started contracts let, or purchase orders issued within 90 days after final approval of a request for appropriation, the appropriation is automatically canceled and a new appropriation is required should it be desired to proceed with the project.

If the amount authorized by the appropriation is not sufficient to complete the project, an "additional appropriation" must be secured before additional money can be expended.

**CONSTRUCTION AND ACQUISITION PROCEDURE**—In large organizations which undertake much of their own construction, either replacements or additions and betterments, a special procedure must be worked out to insure proper administration and accounting for construction. The first step is the issue of the authorization job order or work order, as it is variously called. This covers nature of work, classified estimated cost, estimated time required, and other details. Usually also, the forms provide for a recording of the actual expenditures incurred together with removal costs, salvage etc. A job order ledger controlled by a "construction in progress" account, is often used to which postings are made regularly as the work progresses. As authorizations are completed they are placed in a special file for reference with supporting memoranda attached. After a job is completed, the cost must be distributed to the proper accounts. Figs 4 and 5 show two of the forms used by a paper manufacturer in connection with construction jobs.

Figs 6 to 9 and their descriptions, taken from *Saliers (Depreciation Principles and Applications)* illustrate some of the forms used by a steel corporation in connection with the acquisition of fixed assets.

JOB ORDER TOTAL SHEET									
Direct <input type="checkbox"/>		Expense <input type="checkbox"/>		Repair <input type="checkbox"/>		Construction <input type="checkbox"/>		Job No. _____	
J O Title _____									
See Credit—Exp. Dept.			Credit On acc—Fin. Accounts			Approved—Acct. Audits			
See Jour. Ind—A & Dep.			J Y N		Approved—Exp. Dept.		Approved—Admin.		
J O No.		Group is in Class Code		Are we in line		Total Labor Cost Forward		Total in Cost Forward	
						Described as—Direct Charge Items		Amount	
Submitted by		See Credit—T & Dep.		Estimated Cost		Actual Total—Job Order Cost			

FIG 4 Job Order Total Sheet











used to authorize and to record withdrawal, sale, scrapping, or other disposal of properties. They require the same approvals and are routed in the same manner as appropriation forms. At the bottom of the first two sheets is a journal entry form to cover accounting, one of these sheets being for use of the accounting department and the other for the property records department. The property records department identifies items shown in this report, prices same, computes debits to specific depreciation and obsolescence accounts and the credits to property accounts and withdrawals from investment.

## Plant Accounts

### NEED FOR SYSTEMATIC RECORDS AND PROCEDURES

—In recent years considerable progress has been made particularly in the industrial field, in the development of good plant practice with respect to the maintenance of adequate records and procedures in order to secure effective control over, and proper accounting for, fixed assets. Among the special influences which have contributed to this development are the increasingly stringent requirements of the Treasury Department in connection with **income tax returns** and the activities of the Securities and Exchange Commission.

**CLASSIFICATION AND IDENTIFICATION OF PHYSICAL PROPERTY**—The Chamber of Commerce of the United States in a special bulletin emphasizes the importance of proper classification.

Proper classification is a prerequisite for proper recording of depreciation. It is not unusual to find assets grouped under such general captions as "buildings," "machinery" and "equipment," without anything by way of systematic supporting records. The term "buildings" may include wood concrete steel or brick structures designed for heavy or light use, it may include fencing wood bins docks drainage systems etc. "Machinery" may comprise electrical generators and steam engines hydraulic presses and steam hammers lathes planers boring and milling machines woodworking machinery and small tools. The "equipment" may vary from a locomotive to a pickling tank, from glass furnaces to file systems. The span of useful life of these assets may vary from three to thirty years or more yet all will be given the same rate of depreciation. In such situations it is usually impossible to determine the gross book value depreciation reserve or the undepreciated value of any specific item or type of property.

The costs (or other proper values) of buildings and equipment should be classified in broad groups in the general ledger, or in an intermediate ledger, controlled by one or more accounts in the general ledger. The principal bases on which this classification should be effected are

1. Function or use
2. Probable length of life
3. Location
4. Structural character

A typical grouping of property accounts on a functional basis is

1. Land and land improvements
2. Buildings and fixed building equipment
3. Power plant and power equipment
4. Machinery



- 5 Motors
- 6 Factory furniture and fixtures
- 7 Manufacturing equipment
- 8 Permanent tools
- 9 Internal transportation equipment
- 10 Office furniture
- 11 Transportation and delivery equipment
- 12 Sundry equipment

Classification by location is usually subordinate to classification by use or function. Classification by length of life and physical character can be combined with classification in terms of use. Classification by departments means substantially the same thing as classification by function.

The chart of accounts for fixed assets recommended by the American Petroleum Institute recognizes the following departments:

- |                    |                   |
|--------------------|-------------------|
| 1 Production       | 6 Tank car        |
| 2 Natural gasoline | 7 Marine          |
| 3 Pipe line        | 8 Marketing       |
| 4 Storage          | 9 Other operating |
| 5 Refinery         | 10 Administrative |

This chart provides a complete classification of depreciation reserves matching the classification of cost of property, a commendable feature.

Avery (Accounting for Depreciable Fixed Assets) emphasizes the importance of classification as a basis for sound accounting and control of plant property and presents several illustrative charts of accounts for plant property.

The various trade associations recommend uniform classification systems for the member companies. Moore (N.A.C.A. Year Book, 1934) gives the classification of plant assets recommended in the Standard Accounting and Cost System for the Electrical Manufacturing Industry (Fig. 10). Each plant should adopt the classification best suited for the particular fixed assets owned. The Treasury Department (Bulletin F) states the most generally used classification as "Buildings, Machinery and Equipment, Office Furniture and Fixtures, and Transportation Equipment."

The American Institute of Laundering has worked out an account classification system varying in complexity with the size of the individual laundry (Special Report #113, 1938).

#### Account classifications

- 1 Simplified Laundries doing less than \$500 weekly volume
- 2 Intermediate Laundries doing between \$500 and \$1,200 weekly volume
- 3 Standards Laundries doing between \$1,200 and \$5,000 weekly volume
- 4 Detailed Laundries doing more than \$5,000 weekly volume

#### Standard and detailed asset and reserve accounts

- 113 Land and Improvements
- 114 Buildings
- 115 Power Plant Machinery and Equipment
- 116 Laundry Machinery and Equipment
- 117 Dry Cleaning Machinery and Equipment

# CLASSIFICATION OF PLANT ASSETS AND DEPRECIATION RATES

(Recommended in the Standard Accounting and Cost System  
for the Electrical Manufacturing Industry)

<i>Classification</i>	<i>Per Cent</i>
LAND	0
GRADING AND ASSESSMENTS	10
BUILDING AND STRUCTURES	
1131 Buildings, Wood, Sheet Iron and Stucco	10
Buildings Brick and Wood	4
Buildings Steel and Concrete	2½
1132 Structures	8½
1134 General Service Piping and Wiring	6½
MACHINERY AND TOOLS	
1141 Machinery	8½
1142 Electrical Apparatus	8½
1143 Ovens and Furnaces	10
1144 Conveyor Equipment	16½
1145 Small Tools	20
1146 Electrical Accessories	16½
1147 Molds Jigs Dies and Special Tools	
1148 Metal Flasks	
Cast Iron and Steel	12½
Channel and Rolled Steel	20
Aluminum	10
FOUNDATIONS AND INSTALLATION	
1151 Foundations—Machinery and Electrical Apparatus	16½
1152 Installations—Machinery and Electrical Apparatus	16½
FURNITURE AND FIXTURES	
1161 Factory Fixtures and Equipment	20
1162 Furniture and Appliances in Factory Offices	10
TRANSPORTATION SYSTEM	
1171 Roads and Sidewalks	12½
1172 Railway Tracks and Overhead Equipment	6½
1173 Rolling Stock	6½
1174 Automobiles and Trucks (Gas)	25
1175 Electrical Vehicles and Trailers	16½
1176 Other Conveyances	25
PATTERNS AND DRAWINGS	
1181 Patterns	(a)
1182 Drawings	(a)
UNFINISHED PLANT	0

- (a) It is contemplated that the cost of molds jigs punches dies and special tools and cost of patterns and drawings will be charged to 172—Unliquidated Development and Complaints and liquidated by charges to the cost of production to which they apply. At the option of the company these expenditures may be entered directly against indirect manufacturing expense accounts.

FIG 10 Classification of Plant Assets

- 118 Other Plant Machinery and Equipment
- 119 Collection and Delivery—Trucks
- 120 Collection and Delivery—Other Equipment
- 121 Other Asset Accounts

(NOTE "Reserve for Well Depreciation" is carried for account 113 "Reserves for Depreciation" for accounts 114 through 120, and "Reserve for Office Equipment" for account 121)

Each year the Institute compiles and publishes average laundry cost data. The member plant, using the standard classification, can thus be compared directly with the average of others within the appropriate class for operating costs and efficiencies.

Grouse gives an outline of the numerical unit classification used by his company, both as a means of identifying the items and segregating them for accounting control (N A C A Year Book, 1928).

The entire plant was first classified into three general groups namely Land Buildings, and Machinery and Equipment. The land group required no further subdivision. The buildings group includes all buildings and other construction items and is subdivided, each building being assigned a number from 1 to 90. The machinery and equipment group was subdivided by departments each department being numbered from 100 up. Within the foregoing limits therefore our numerical classification enables us to number each building consecutively within the limits 1 to 90 and the miscellaneous construction items from 91 to 99 and with respect to machinery and equipment, manufacturing departments are assigned department numbers from 100 to 148, and service and miscellaneous departments are assigned department numbers from 149 up.

Each building and each department are further subdivided into individual units of construction or machinery and equipment and decimal sub numbers assigned to each unit. For example each building is subdivided as follows: 01 Excavation 02 Foundation 04 Masonry 07 Iron Construction 08 Wood Construction 11 Windows and Doors 12 Sheet Metal Work, 13 Roofing and so on.

The complete unit number assigned to each of these subdivisions would be, for example 408 as representing Wood Construction in Building No 4.

With respect to unit classification of machinery and equipment as indicated above, a department number is assigned to each department and in case of manufacturing departments this is done in the order of manufacturing processes as nearly as possible. Subdivisions are assigned in each department from 01 up, an individual number being assigned to each specific machine or equipment unit contained therein. By way of further illustration the unit number which might be assigned to a mill would be 10104 as indicating unit No 4 in the millroom.

With respect to certain classes of equipment it was not practicable to assign an individual unit number to each item, as for example, cranes and hoists laths and molds permanent tools foundry patterns furniture and fixtures, plans tracings and drawings tanks kettles and vats and the like. Such items therefore are classified into three respective groups by departments and to each group is assigned a three digit subunit number, for example, all cranes and hoists in the millroom would be designated by the unit number 101001.

**PLANT AND DEPRECIATION SCHEDULES—SECURE REQUIREMENTS**—The following outlines the requirements of the Securities and Exchange Commission with respect to plant and depreciation schedules in registration statements.

## SCHEDULE II PROPERTY PLANT AND EQUIPMENT (1)

(Column A) Classifications (2)	(Column B) Balances at the begin- ning of the fiscal year as per accounts	(Column C) Additions at cost (8)	(Column D) Retirements or sales (4)	(Column E) Other changes— debit and/or credit— describe (5)	(Column F) Balance at close of fiscal year— balance sheet caption 12
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1 Comment briefly on any significant and unusual additions abandonments or retirements of or any significant and unusual changes in the general character and location of principal plants and other important units which may have occurred within the fiscal year

2 Show by major classifications such as land buildings, equipment leaseholds Items of minor importance may be included under a miscellaneous caption If such classification is not practicable this may be stated in one amount

3 If the changes in property accounts in column C represent anything other than additions from acquisitions state clearly the nature of the changes and the other accounts affected If cost of property additions represents other than cash expenditures explain

4 If the changes in column D are stated at other than cost, explain where practicable

5 State clearly the nature of the changes and the other accounts affected When provisions for depreciation, depletion and/or amortization of property plant and equipment is credited in the books directly to the asset accounts the amounts shall be stated in column E, with explanations including where charged

## SCHEDULE III RESERVE FOR DEPRECIATION DEPLETION AND AMORTIZATION OF FIXED ASSETS (1)

(Column A) Reserves for classifications of property as listed in Schedule II (2)	(Column B) Balance at beginning of fiscal year as per accounts	(Column C) Additions		(Column D) Total of Column B and Column C	(Column E) Charges to Reserves		(Column F) Balance at close of fiscal year—balance sheet caption 13
		Charged to profit and loss	Charged to other accounts—describe		Retirements removals and replacements	Other—describe	

1 Where other reserves are created in lieu of depreciation reserves the same information shall be given with respect to them

State the company's policy with respect to the provisions for depreciation depletion and amortization or reserves created in lieu thereof during fiscal year

Insofar as amounts for depreciation depletion and amortization are credited to the property accounts such amounts shall be shown in schedule II as there required

2 Where practicable reserves shall be shown to correspond with the classifications of property in schedule II, separating especially depreciation depletion and amortization

## Property Ledger

**NECESSITY FOR PROPERTY LEDGER**—The modern property record has evolved both from a necessity of a permanent and reliable basis for depreciation costs and as a recording medium for the

yearly additions and disposal of capital assets. Grouse (N.A.C.A. Bulletin vol 11) lists four major purposes for detailed property ledgers:

- 1 The need for supporting detail with respect to capital investment accounts
- 2 The basis for more accurate depreciation charges and consequent effect on cost of operation
- 3 A more accurate basis for determining insurable values and for substantiating claims for losses sustained
- 4 A more sound basis for tax returns both income and property

To these the Metropolitan Life Insurance Company in a special bulletin adds the following:

- 1 To promote operating efficiency
- 2 To facilitate preparation of accounting data
- 3 To encourage abandonment of superfluous facilities
- 4 To control capital expenditures
- 5 To facilitate computation of data required by regulatory agencies

Treasury Decision 4422 shifted the burden of proof as to the reasonableness of the annual depreciation deduction from the Treasury Department to the taxpayer and has thus caused many corporations to install complete property records to justify their claims. The Decision states:

Taxpayers must furnish full and complete information with respect to the cost or other basis of assets in respect of which depreciation is claimed, their age, condition and remaining useful life, the portion of their cost or other basis which has been recovered through depreciation allowances for prior taxable years, and such other information as the Commissioner may require in substantiation of the deductions claimed.

(See later discussion of TD 4422 and Mimeograph 4170.)

**ADVANTAGES OF PROPERTY LEDGER**—Kilduff lists the following results which may be expected from an efficient and properly operated property record (N.A.C.A. Bulletin, vol 10):

- 1 A complete history and full description of each important property item at a central point
- 2 A detailed record in support of general ledger and property ledger accounts
- 3 A detailed record in support of the depreciation charge thus acting to prevent over- or underdepreciation
- 4 Record of property by locations for management, insurance, taxing and cost purposes
- 5 Increase in accuracy of accounting since all fixed capital accounting is subject to analysis
- 6 Record in case of disaster which makes it possible to obtain a description and cost of the property destroyed
- 7 Dependable data are in ready form for budgeting purposes
- 8 If form is properly designed, information is available for accounting, engineering, and manufacturing departments and consolidates at one point various partial records of properties which are usually to be found in the above mentioned departments
- 9 Record of cost of repairs to individual machines, etc., is also available, as a means for gauging the economy of operating certain types of machines, etc.
- 10 Figures are available for determining fixed charges by any group desired as basis for establishment of certain functional costs.

The following is adapted from Hosmer (Harvard Business Review, vol 14)

If plant ledgers, or detailed records in other form are available it is relatively simple to credit the proper amounts out at times of retirement. If no such records are available it becomes necessary to appraise the assets retired as accurately as possible and credit plant on this basis.

Hosmer states that apparently only 10% to 15% of industrial corporations with plant of over \$500 000 use "carefully administered plant ledger systems" and that possibly 50% have informal records, such as invoices of machinery purchased and copies of contracts, from which reasonably accurate data for booking retirements may be obtained.

**PRINCIPLE OF SUBSIDIARY PLANT LEDGER**—Booser (NACA Bulletin, vol 19) lists two fundamental requirements of subsidiary plant records

- 1 The detailed ledgers must be in agreement with the general ledger's controlling accounts
- 2 The detailed ledgers should agree with the assets the physical items actually in existence

This second requirement is emphasized by Hossack (NACA Year Book, 1936) He says

I have seen plant accounts supported by very detailed item records of costs where there had never been a serious attempt to determine whether the property was still in existence. The capital assets as recorded on the books whatever the basis of value, should agree with the assets actually in existence and used or useful to the business. The property accounts should record the cost on other basis of the property they purport to control.

**UNIT CONTROL**—A system of plant and property records should maintain an individual record for each unit of plant and property containing all pertinent facts from the time of its acquisition until its disposal. Information recorded should include

- 1 A description of the property whereby it can be readily identified at any time and wherefrom engineering and operating departments can secure reliable and complete technical data.
- 2 A record of original location and history of all subsequent relocations of the item.
- 3 A record of the original and supplementary costs of the item with adequate reference to all documents which support these costs.
- 4 A record of repairs renewals and maintenance.
- 5 Loss of value through depreciation.
- 6 Report of disposition through sale or mandate.

Hossack, DeVitt, Rodey and other authorities stress the desirability of "item" or "unitized" subdivision and control. Hossack insists that "with a properly conceived record an item control can be maintained with no more cost than the ordinary accounting methods." DeVitt (NACA Year Book, 1936) recommends the use of punched cards in securing unit control.

**TREATMENT OF TOOLS AND RELATED ASSETS**—Many business concerns have a considerable investment in such assets as tools, dies, containers, and other plant elements of relatively short useful life.







and of relatively low unit cost (for the most part). For such property a detailed accounting is evidently a rather difficult matter, although it is clear that careful control of such property is needed. Avery (Journal of Accountancy, vol 71) writes substantially as follows:

The same theoretical consideration is involved here as in accounting for any other type of depreciable fixed asset. Each unit in the tools account could be identified by number or symbol and placed in a unit control system. However, the multiplicity of units and the low unit cost, especially in the case of small tools, makes the expense of operating such a plan prohibitive.

Unit cards can be made for the larger and more expensive tools and a control account set up for both the asset and depreciation reserve.

Some concerns charge small tools and similar items to operations as purchased, and show no inventory of such assets in the balance sheet, others charge purchased tools to the tools account and determine the charge to operations by comparing opening and closing inventories of tools. The most satisfactory procedure—where detailed accounting is not feasible—is the practice of capitalizing all purchases of tools by principal classes and accruing depreciation on each group at an appropriate average rate. The cost of units retired may then be computed on the assumption of first-in, first-out.

**PROPERTY LEDGER FORMS**—Fig 11 is a commercial standard equipment record. Each sheet is for one item of building or equipment and the total of all sheets must tie in to the general ledger control accounts. Entry of acquisition cost, installation charges, and any sales or retirements as they occur in the center section gives the details behind the control accounts. The depreciation record provided in the lower section is designed to show the amount which has been charged monthly to operating expense and credited to the Reserve for Depreciation. The book value of any items of equipment equals the amount shown in the Balance column less the footing of the amounts entered in the Depreciation section.

The upper part of the depreciation section is arranged for the determination of remaining life and calculation of a new depreciation rate. U. S. Treasury Decision 4422 requires that the remaining useful life of fixed assets and their depreciation rates be redetermined whenever it appears that prior rates are no longer applicable and substantial adjustment is necessary.

Fig 12 illustrates a complete plant ledger card suitable for use with Keyport equipment. It is an economical form of plant ledger suitable where repeated sorting may be required without the expense of electric sorting and tabulating equipment. The reverse side of the form constitutes a repair and maintenance record, as well as a record of capital additions.

**DEGREE OF SUBDIVISION**—What is needed is a card or sheet for each distinct unit, or each entirely homogeneous group. In some cases in fact the analysis of cost should go beyond the distinct structure or machine to the major structural parts. Thus, the cost of an automobile engine, or the cost of the tires, may be a proper subject for separate and distinct record. However, this last need can usually be



seived through the use of a separate column or line on the card or sheet applicable to the individual structure or machine. It is out of the question to set up separate sheets or cards for each distinct unit in the case of such assets as hand tools, furnishings, and the like. Here the periodic inventory sheets, with a line for each item or collection of similar items, is the ultimate record, the sheets being classified under such headings as dishes, cutlery, etc., for example.

In discussing the breakdown of the American Petroleum Institute chart of accounts, Newlove, Smith, and White (Intermediate Accounting) say that the scheme of subaccounts "will vary according to size of company, nature of operations and requirements of management as to financial and statistical details." They give the following illustrative excerpt:

Account 301 00 Production Department, Plant and Equipment Producing Properties—

301 00 1 Rigs and Rig Irons	301 00 4 Engines
301 00 2 Tanks	301 00 5 Casing
301 00 3 Boilers	301 00 6 Tubing

According to Hosmer (Harvard Business Review vol 14) "most in stallations seem to show about 1 000 accounts in the plant ledgers for each \$1,000,000 of gross plant."

**PUNCHED CARD PROPERTY CONTROL**—A tabulating card is written for each unit of property (Fig 13). This record is designed to include in writing all pertinent data subject to managerial analysis. These data are punched in the same card on which the written data appear. Factors dealing with depreciation are punched in a separate card using the first card as a source document.

As additional assets are acquired, additional property and depreciation record cards are prepared and added to the files. Whenever a unit of equipment is retired, the corresponding cards are removed from the files. Thus a subsidiary ledger supporting Plant and Equipment Control is constantly maintained. The cards are also used to prepare periodic summaries of fixed assets, according to desired classifications (Fig 14).

DeVitt describes the punched card property ledger system set up and in use by a paper manufacturer (NACA Year Book, 1936). The material below is taken from that paper.

**Unit Control**—The starting point of the ledger is a departmentalized unit appraisal. The value of each building was compiled as was the value of its equipment. The company had the detailed values of the roofs, floors, and foundations which were a part of the building structure. The appraisal gave the value of each machine unit in the plant broken down to the components, such as motors, wiring, safety guards, and piping. Cost centers were established and the depreciation charges of the buildings on each were allocated by square feet of occupancy.

**Control Accounts**—Ten general ledger accounts to separate the larger classifications of property were set up. Each of these was broken down into groups of common equipment. For example "Machinery and Equipment" account was classified by steam engines, motors, gear reduction units, motor wiring, safety guards, foundations, and piping.



PROPERTY LIST									
		DATE		MAY 30		19			
LOCATION	SERIAL NO.	C	U	ED	BT OFF	T	A	COS	CRD. VALU.
10	12361	7	15	88	273680	87358		862276	
10	12304	8	80	88	80162	5041		18488	
10	18206	1	01	89	629175	62918		629175	
10	21791	4	30	29	14700				
10	38422	8	10	30	28000				
10	38425	8	10	30	363657				
10	38426	8	10	30	59040				
					13884.4				

DISTRIBUTION OF DEPRECIATION CHARGES	
D	CRD. VAL.
1	50540
2	216872
3	97465
4	150448
5	386174
	909499

CURRENT VALUATION REPORT									
Sullivan Plant					Depreciation				
ITEM	NO.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Buildings	1	746835	753057	757459	760010	762516	765016	767516	770016
Building Equip	2	29821	29821	29821	29821	29821	29821	29821	29821
Electrical Equip	3	2120	0	260057	55150	700050	100050	100050	100050
Refinery Equip	4	17510	200050	17510	200050	200050	200050	200050	200050
Chemical Equip	5	3510	978172	440073	50662	50662	50662	50662	50662

FIG 14 Fixed Property Report Prepared on Tabulating Accounting Machine

**Equipment Classification Code**—Most of the types of equipment were in use throughout all the departments of the plant and a three place code was devised to catalog the assets according to the information incorporated on the card. Building Lighting was 106. The "1" identified the general ledger account, "Buildings," and the last two figures indicated the asset account classification breakdown. Motors were 230 in the code. The "2" identified the Machinery and Equipment general ledger account and the last two the breakdown. A sorting of cards by the first figure of the code thus ties all the cards into the general ledger control.

Another code was necessary to allocate depreciation and identify and locate the equipment, the solution being a six-place code. The first figure indicated the manufacturing division, the second the department within the division, the next two the cost center within the department, and the last two the specific machine within the cost center. For example, 25-05-12 was a machine in the paper mill division, machinery department, No 5 paper machine costing center, and was a stock pump to the beater chest.

The three-digit asset account classification is used to tie up any appurtenances which are a part of the unit with the equipment card itself. The location showing the main building, the annex, and the floor was also punched into the card. These two codes along with the building classification absolutely identified any machine and kept the detail record in agreement with the general ledger.

**Depreciation Control**—When item depreciation rates are used, depreciation may not be overaccrued on any unit of property. A selective sorting of any year pulls out all the cards expiring that year, so it is impossible to overaccrue any item. Whenever property items become fully depreciated and are still in use an "X" is punched in the proper field. The card can then be left in the active file and the class selector on the tabulator eliminates all such items from the reports.

Another use of the cards is in connection with property insurance records. The card form locates each piece of equipment by the building code or by the prefixes for "yard" or "outside of plant." The class selector excludes the noninsurable items such as foundations, below-ground piping, sewers, etc., without disturbing the order of the cards or necessitating manual sorting. A punched card file protects against the loss of small items which might be overlooked in reporting fire losses.

DeVitt ended his paper with a summary of advantages of punched card property ledgers:

- 1 Complete factual data being available in practically any form required
- 2 Accuracy
- 3 Speed
- 4 Confidence in the figures presented
- 5 Less effort
- 6 Low cost of operation

## Depreciation Factors

**DEPRECIATION DEFINED**—Discussion of depreciation involves engineering, as well as accounting aspects. The following definitions stress the accountant's point of view.

Himmelblau (Third International Congress on Accounting) refers to depreciation as the process "of spreading the value of a fixed asset over the accounting periods comprising its service life." According to Montgomery (Auditing Theory and Practice) depreciation is "an allocation of the entire cost of depreciable assets to the operating expenses of a series of fiscal periods." J. B. Bailey (Journal of Accountancy, vol. 74) describes depreciation as "the accounting for the consumption or the wasting of invested capital." In all of these statements the essential conception is that of assigning the cost of property to the accounting periods included in useful life.

Depreciation for income tax purposes is defined by the U. S. Treasury Department, Bureau of Internal Revenue (Bulletin "F") as:

A reasonable allowance for the exhaustion, wear and tear of property used in the trade or business including a reasonable allowance for obsolescence.

**ACTUAL VERSUS THEORETICAL DEPRECIATION**—Included in the cost of any unit produced is some percentage of the cost of the plant and equipment employed during production. The problem of the determination of the value transferred from the producing assets to the produced asset is twofold.

- 1 An accurate estimate of the life expectancy of the assets with any possible salvage value
- 2 A consideration of what basis to use to allocate the cost of the asset over this estimated service life

The above two factors may be used to determine either actual or theoretical depreciation. The terms are defined by Maistron and Agg (Engineering Valuation) as follows:

**Actual depreciation** is the true loss of value of property units during service as determined by:

- 1 Competent valuation experts
- 2 Studying data obtained by careful examination of the units
- 3 The application of correct depreciation principles to the observed facts

**Theoretical depreciation** is depreciation calculated by some assumed mathematical formula for its distribution throughout the average service lives of similar property units serving under similar conditions.

### OTHER DEFINITIONS —

**Depreciation, Functional**—Saljeis (Depreciation Principles and Applications) states that functional depreciation "results from the obsolescence or inadequacy of a plant unit, a combination of plant units, or an entire plant."

**Depreciation, Unearned**—The same source defines unearned depreciation as "that depreciation which has been incurred in giving service and for which no return through revenue has been received. It is in some respects similar to deferred maintenance."

**Depreciable Unit**—Item or group of items, of physical property which is separately depreciated.

**Amortization**—Congress and the Treasury Department have used the term amortization to designate the extraordinary depreciation of "war facilities," a temporary situation. The cost of construction or acquisition of certain fixed assets of land, building and machinery which are deemed necessary as an aid in production for national defense may be charged off over a sixty months' period. The necessary formalities must be complied with and certain certificates obtained from the War or Navy Departments. The expression is also sometimes applied to the extinguishment of value in the case of an entire plant not subject, as a practical matter, to replacement.

**Accrued Depreciation**—Maistron and Agg (Engineering Valuation) define accrued depreciation as the "total actual loss of value between the date first put into use and the date of valuation of property."

**Service Life**—Kurtz (Life Expectancy of Physical Property) defines service life as "the period during which a unit of physical property is capable of rendering efficient and economical service."

**Salvage**—The value an article possesses for some use other than that to which it has been devoted, or resale.

**Net Salvage Value**—The gross salvage value of an item of physical property less the cost of removal.

**Scrap, or Junk Value**—The net value realized when the unit of property is scrapped or broken up in order to use it as manufacturing material

**CAUSES OF DEPRECIATION**—The Appraisers' and Assessors' Manual states that the physical life of a building is dependent upon the following factors

- 1 Location
- 2 Type of building
- 3 Kind of construction
- 4 Character of construction
- 5 Natural decay and disintegration
- 6 Wear and tear
- 7 Maintenance

Each of these factors has a very definite effect on the service life of the building. Climatic conditions vary over the country, brick buildings depreciate less rapidly than do wood or brick and wood ones, the intensity of use brings on more or less wear and tear, and the mere passage of time brings about a loss of service value and a gradual decay and loss of economic usefulness. Montgomery (Auditing Theory and Practice) divides the causes of depreciation into those which are more or less predictable at the time of installation and those due to unforeseen developments. Under the first group are

- 1 Ordinary wear and tear from operation
- 2 Physical deterioration resulting from time and the elements
- 3 Inadequacy
- 4 Obsolescence
- 5 Diminution in supply of raw material
- 6 Negligence

Under the second group are those which may hasten the loss in service value of the property and necessitate replacement or complete abandonment

- 7 Structural defects
- 8 Diseases such as electrolysis crystallization etc
- 9 Extraordinary wear and tear from operation
- 10 Extraordinary obsolescence

Maiston and Agg (Engineering Valuation) make a somewhat different analysis and allocation of depreciation causes, based on physical and functional classifications

#### Physical causes

- 1 Sudden physical damage due to miscellaneous accidents and disasters
- 2 Physical decrepitude due to physical deterioration and wear and tear

#### Functional causes

- 3 Inadequacy and supersession
- 4 Obsolescence

To these may be added the following

- 5 Limited possibility of use
- 6 Cessation of demand



**Unusual Damage**—In using equipment, accidents and breakage are more or less unavoidable. Such occurrences affect service life, even when repairs are possible. Wherever it is feasible and economical to do so the risk should be covered by an appropriate form of insurance.

Unusual deterioration often results from unnecessary exposure to weather and inadequate maintenance. If, however, rapid deterioration is a commonplace in the industry, and it is uneconomical to protect and maintain in accordance with good engineering standards, the condition can hardly be said to be "unusual."

Damage resulting from storms, floods, etc., also affects service life in particular cases. Where such risks are fully covered by insurance there is no special accruing loss in addition to insurance premiums, there is no depreciation on account of the possibility of such casualties. Where the risk is not practically insurable there is little basis on which to predict the occurrence of the disaster in particular cases and hence no accruing depreciation. It is of course possible to estimate depreciation liberally with a view to providing some margin for casualties.

**Wear and Tear**—Wear and tear as a cause of depreciation includes both mechanical and natural actions. Mechanical actions are friction, vibration, and other processes arising from the actual use and operation of plant and equipment. Natural actions include wastage due to oxidation, electrolysis, crystallization, and similar processes which are inevitable with the passage of time. Both are the natural result of continuing use or increasing age. They form the basis of estimating life expectancy and setting up methods of depreciation accounting. Ordinarily current repairs are excluded. In spite of the wide differences in opinion among accountants and industrial executives as to how depreciation should be estimated and accounted for, it is universally expected that wear and tear in use and the wastage due to passage of time, eventually remove from profitable service practically all classes of industrial buildings and equipment. Further the propriety of charging the accompanying loss in value to operating expense is generally admitted. Experience and accumulated facts enable those familiar with the nature and use of industrial property to forecast its natural life with a reasonable degree of certainty.

The effect of ordinary use in operation can generally be predicted with more assurance than the effect of any of the other depreciation factors. That is, years of experience in dealing with a particular class of equipment makes it possible to forecast average service life with rough accuracy as far as the influence of normal physical use is concerned. Even probable physical life, however, is uncertain due to variable repair policies and operating conditions.

**Inadequacy and Supersession**—Nash states (Third International Congress on Accounting) that inadequacy "includes those causes of retirement due to growth and physical development of the business." Put more broadly inadequacy may be said to exist whenever changes in the conditions of operation (exclusive of invention and technical development) render assets unsuited for further service. Thus increasing traffic may make it necessary to retire light rails in favor of heavier rails or a shift in the character of traffic may require the substitution of box cars for flats.

Kester (Advanced Accounting) distinguishes the following causes of inadequacy

- 1 Change of business policy or ownership for example, where a plant is moved from one community to another
- 2 Business development, for example where a marked and unexpected widening of the market occurs
- 3 Governmental action for example, where municipal requirements make necessary the replacement of overhead wires with underground conduit construction

Predicting the effect of this factor upon service life is evidently a difficult matter, although Saliers suggests (Depreciation Principles and Applications) that "inadequacy is easier to forecast than obsolescence"

Nash uses the term supersession to refer to retirements "originating in governmental requirements or public demands" On the other hand, Marston and Agg define supersession as representing those "cases where the same service can be rendered with greater efficiency by quite different kinds of structures and equipment" The latter definition makes it evident that supersession is a form of obsolescence

**Obsolescence**—Obsolescence represents a shrinkage in value of fixed assets due to the new inventions or improvements in design of existing assets Montgomery (Auditing Theory and Practice) states that it "results from improvement in methods machines formulae and processes, and substitution of products or cessation of demand" The Treasury Department (Bulletin F) defines obsolescence as

The process of becoming obsolete due to progress of the arts and sciences changed economic conditions legislation or otherwise which ultimately results in the retirement or other disposition of property As said by the Supreme Court in *United States Cartridge Co v United States* (281 U.S. 511 516) "Obsolescence may arise from changes in the arts shifting of business centers loss of trade inadequacy supersession prohibitory laws and other things which apart from physical deterioration operate to cause plant elements or the plant as a whole to suffer diminution in value"

Obsolescence differs from inadequacy in that an obsolete piece of equipment has become economically of less value than a new, more efficient and time-saving development, while an inadequate condition results from increased demands made upon the facilities to such an extent that the old equipment is unable to do the work Saliers (Depreciation Principles and Applications) gives an illustration of the difference between inadequacy and obsolescence

A 40 Hp engine is replaced by a 60 Hp engine of the same type because the 40 Hp engine is inadequate to the demands made upon it A 40 Hp engine may however be replaced by a 40 Hp engine of an improved type not because it is incapable of doing the work but because it is not economical i.e. it is obsolete

Two principal forms of obsolescence are generally recognized the first a sudden loss of useful value brought about by some revolutionary or radical change and the second a more gradual reduction of usefulness due to the accumulated effect of small improvements or changes introduced from time to time in the area or industry generally The Treasury Department (Bulletin F) states

Extraordinary or special obsolescence can rarely be predicted prior to its occurrence. However this does not necessarily imply that the asset already must have been completely discarded or become useless. Deductions for obsolescence of this type may be taken over the period beginning with the time such obsolescence is apparent and ending with the time the property will become obsolete. In every case the burden of proof is entirely upon the taxpayer to establish a claim.

Normal obsolescence is caused by factors which can be anticipated with substantially the same degree of accuracy as other ordinary depreciation factors such as wear and tear, corrosion or decay. Accordingly it is included in estimating the normal useful life of depreciable property, the effect of which is to include the allowance for normal obsolescence in the depreciation allowance.

The Appraisers' and Assessors' Manual differentiates building obsolescence by internal and by external causes.

Internal obsolescence may be due to one or more of the following conditions:

- 1 Poor or eccentric original design
- 2 Change in type of construction
- 3 Change in kind of construction
- 4 Change in utility demand

External obsolescence may result from one or more of the following conditions:

- 1 Poor original location
- 2 Change in the character of the district
- 3 Specific detrimental influences
- 4 Zoning laws

Victor Stempf (Journal of Accountancy, vol. 69) illustrated the fact of obsolescence with a quotation from the U. S. Steel Company's published report of 1935 explaining an adjustment for \$270,000,000 made to write down property assets. He quoted:

Broadly, these adjustments are attributable to the developments in the art and mechanics of steel making which have operated to reduce the normally expected life of such facilities, and to changes in plant location based upon shifting markets and transportation facilities.

With the general speeding up of technological progress, obsolescence rather than physical depreciation becomes the determining factor in plant retirements.

**Limited Possibility of Use**—Service life sometimes depends upon some condition, recognized and inherent in the situation from the outset, which is external to the physical character of the unit itself. Montgomery (Auditing Theory and Practice) refers to this factor as "diminution in supply" and as applying to "plant facilities assembled for a specific purpose of limited duration." In mining, for example, buildings, underground construction, and equipment generally have a service life not in excess of the period of exploitation. The Bureau of Internal Revenue recognizes this fact in suggesting that the equipment of oil and gas wells should be depreciated at a rate corresponding to that used in calculating depletion of oil and gas reserves. In this connection it should be borne in mind that particular units of mining equipment may have a useful life much shorter than that of the enterprise as a whole and also

that depreciation may continue even when the property is operating on a reduced basis or entirely shut down

The period of use of specialized war facilities is generally limited to the duration of the war emergency

**Cessation of Demand**—This factor is usually treated as an element in general obsolescence, but it nevertheless has a special character. Often the falling off in the demand for a particular product is a decisive influence in determining the date of property retirement. A piece of equipment may be of the very latest and most improved type, and entirely adequate for the purpose intended, but its service life is gone (ignoring possibility of conversion to another use) when the demand for the product has disappeared. A shift from peacetime to wartime production, or vice versa, naturally produces a radical modification of the effective demand for many classes of goods

**ESTIMATING SERVICE LIFE**—Estimating service life, the essential component in all depreciation calculations is primarily a matter of technical and financial experience. The accountant must use estimated service life in determining the periodic charge recorded. The close relation between maintenance and depreciation and the influence of good classification of property, furnish ample justification for asking the accounting department to cooperate in the preparation of life estimates

The first step is to estimate the probable life assuming that the deterioration accompanying normal operation is the principal reason for a limited life. This estimate must be based primarily on the opinions of engineers and operating men and on tabulations covering histories of similar units in similar service, if such data are available. Special consideration must be given to each of the following

- 1 Adequate classification
- 2 Probable intensity of operation
- 3 Maintenance policy
- 4 Retirement condition
- 5 Obsolescence

Kester includes "climatic conditions" in a list of factors to be considered in setting the depreciation rate

**Adequate Classification**—In practice the tendency is not to go beyond the distinct structure or unit of equipment in classifying cost for depreciation purposes. However, as Devine (*Accounting Review*, vol. 18) emphasizes a unit of property such as a delivery truck is composed of structural items and accessories "having, under ordinary circumstances, widely differing lives." In dealing with such property segregation of such portions of total cost as are assignable to major parts subject to separate renewal would be desirable, but in practice this type of classification is not always feasible. (See discussion under Unit Control earlier in this Section)

**Intensity of Operation**—In general the greater the intensity of operation the shorter the life. A machine operated at high speed and 24 hours per day can be expected to wear out more rapidly than one operated at lower speed and intermittently. In the case of buildings, on the other hand, operating intensity has little or no effect in the typical

case During periods of war production the question of "accelerating depreciation" through the use of "activity factors" becomes a serious problem

**Maintenance Policy**—The depreciation allowance is intended to cover the estimated reduction in utility value occurring in spite of ordinary current repairs, the latter cover expenditures made to keep the physical plant in efficient, safe operating condition. Examples of maintenance are the inspection, painting and repair of structures making good damages from wind, flood or weather and repairing machinery. Maintenance costs are operation expenses, paid from current income as they are incurred. Depreciation is the inevitable loss of value which accrues in spite of maintenance expenditures and can only be made good by replacements with new units of property. Maintenance and repairs represent an effort to maintain operating efficiency in order that revenue or income may continue uninterrupted.

**Retirement Condition**—This is a matter of judgment and company policy. Not all managements agree, for example, as to how long motor equipment should be used before being traded in. This is a matter that can be, if desired, resolved mathematically by balancing maintenance and productive output on the old equipment against similar factors for the new.

**Obsolescence**—The preliminary estimate must be adjusted to allow for obsolescence and other special factors which are external to physical condition and ordinary standards of operation, and cannot be taken care of by insurance. Here there is little opportunity for precise calculations, reasonable estimating in the light of all evidence and opinion available, is all that can be hoped for. One possibility of course, would be to avoid making any attempt to accrue the effect of external factors through depreciation charges, this would mean the recognition of retirement losses when they occurred and would warrant the accumulation of additional "surplus" as a safety measure. Most accountants and business managements however, feel that despite the great uncertainty as to the influence of such factors in particular cases some consideration should be given to them in estimating service life. Experience shows clearly that service life is very frequently reduced because of obsolescence and related conditions, and if this fact is ignored the result is understatement of operating costs and overstatement of periodic income. The cost of property should be written off during its useful life and in view of the uncertainty a conservative position should be taken. Even such a crude calculation as that of the manager who halves service life as estimated on the basis of physical operating conditions alone, to cover the factor of obsolescence, is to be preferred to no adjustment.

**EQUIPMENT MORTALITY TABLES**—Mortality or life experience tables have been compiled by Kurtz (Life Expectancy of Physical Property). The objectives of such tables are

- 1 To establish mortality tables of physical property on an actuarial basis
- 2 To develop the life characteristics of different classes of physical property
- 3 To develop the relations and to determine the laws between the various life characteristics

Life Experience Data of Physical Property

Age in Years	Number of Units Removed during $\frac{1}{2}$ Year Preceding and $\frac{1}{2}$ Year Following Given Ages	Number of Units Remaining in Service at Given Ages
(1)	(2)	(3)
1	5	143
2	12	138
3	18	126
4	20	108
5	24	88
6	19	64
7	17	45
8	14	28
9	9	14
10	5	5
	143	

FIG 15 Life Experience Data of Physical Property

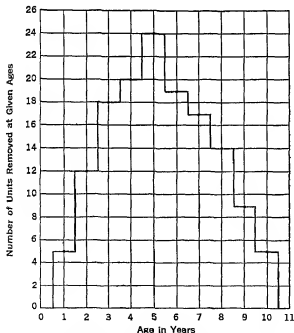


FIG 16 Distribution Curve of Life Experience Data

From a study of a group of mortality tables Kurtz concludes that the relations between certain life characteristics of physical property are of the nature of laws, which permit of a scientific determination of the life expectancy of equipment and its attending problems, and that the observations regarding the life of physical property can be classed as natural phenomena. Mortality curves plotted from tables were found to group themselves into seven types. Three methods for compiling mortality tables are explained and appraised:

- 1 Individual unit method
- 2 Annual rate method
- 3 Turnover method

**INDIVIDUAL UNIT METHOD**—The simplest way of compiling life experience data of a given type of physical property is to record the age in years of each individual unit of property of that class as it goes out of service. When a large number of such individual lives have thus been recorded, the data can be summarized and presented in the form of a table as shown in Fig. 15. Thus, the table shows that 5 units were removed at age 1, 12 at 2, 18 at age 3, 20 at age 4, etc., until the end. When data of this table are plotted as shown in Fig. 16, the well-known distribution or normal frequency curve results.

To obtain the survivor curve it is only necessary to determine the total number of units in the group, and on the assumption that they were all placed in service at age 0, determine how many survive the subsequent ages. Such a table showing the number of units of a given group removed each year as well as the number of units surviving each year constitutes a mortality table, and the graph obtained from plotting the survivor data therefrom is commonly called a mortality curve. This curve is shown in Fig. 17, for the illustrative data given in column 2, Fig. 15.

An adaptation of this method is developed by Carroll (NACA Bulletin vol 23). He calls it the composite original group method, a group representing a year's additions to plant accounts. Over a long period of time a composite picture is obtained of the experience with all groups. Figs. 18 and 19 show the results of a study by Carroll. The survivor curve has been projected beyond the 20 year limit of Fig. 18, using a modified Gompertz curve.

**Computing Average Life, Expectancy, and Probable Life**—The average life represents the anticipated future life at age 0 of an average unit of property. In Fig. 17 the ordinates of the mortality curve represent the survivors of the total number of units at age 0, and the abscissas show years in service. The area under the curve represents either unit service years, or percent years. Hence

$$\text{Average life in years} = \frac{\text{Total unit years}}{\text{Units in service age 0}}$$

$$\text{or} \quad \frac{\text{Total percent years}}{100}$$

For the example given in Fig. 20 which forms the basis for the survivor or mortality curve (Fig. 17), the average life equals 5.63 years, which is the total of column (4) divided by 100. Since the total of

column (4) represents the total service years, the same result can be found on line 1 of Fig 20, in columns (5) and (6)

Life expectancy is the anticipated future life at any given age of an average unit of property. Hence, the life expectancy of a group of units at any given age is equal to the quotient of the total area under the mortality curve to the right of the ordinate at the given age, divided by the number of units surviving the given age. The results are shown in Fig 20, column (6). To determine life expectancy at a given age it is, thus, only necessary to evaluate the area under the mortality curve to

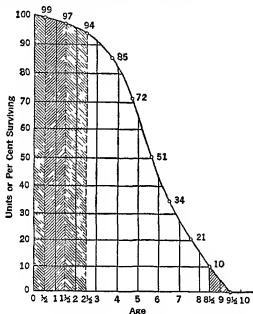


FIG 17 Survivorship Curve

the right of the given age ordinate and to divide this area by the survivors at that age. If the ordinate is expressed in number of units of property the area will be expressed in unit-years and the life expectancy is obtained by dividing this area by the number of units still in service at that age. If the ordinates are given in per cent of the number of units in the group at age 0, the area will be expressed in percent-years, and the life expectancy is obtained by dividing this area by the percent units in service at that age.

Areas corresponding to the various ages can best be evaluated by dividing the area under the mortality curve into strips 1 year wide. By subtotalling the areas of these strips from right to left the area to the



Age in Years	Plant Cost Subject Retirement at Beginning of Indicated Age Interval	Plant Cost Retired During Indicated Age Interval	Remainder—Plant Cost Surviving at End of Interval Which Had Been Exposed to Retirement During Interval	Per Cent of Plant Cost Exposed to Retirement During Interval Which Survived	Per Cent of Original 100% Surviving at Indicated Age
1/4	\$225 000 00	-	\$225 000 00	100	100
1	208 246 00	-	208 246 00	100	100
2	191 787 00	192 00	191 595 00	99 9	99 9
3	178 476 00	357 00	178 119 00	99 8	99 7
4	163 099 00	979 00	162 120 00	99 4	99 2
5	150 899 00	302 00	150 597 00	99 8	99
6	137 748 00	-	137 748 00	100	99
7	125 957 00	1 260 00	124 697 00	99	98
8	114 340 00	1 372 00	112 968 00	98 8	98 8
9	102 045 00	204 00	101 841 00	99 8	98 6
10	91 950 00	552 00	91 398 00	99 4	96 5
11	80 565 00	403 00	80 162 00	99 5	95 5
12	70 196 00	2 457 00	67 739 00	96 5	92 2
13	58 651 00	235 00	58 416 00	99 6	91 8
14	51 716 00	1 810 00	49 906 00	96 5	88 6
15	42 374 00	43 00	42 331 00	99 9	88 5
16	34 206 00	513 00	33 693 00	98 5	87 2
17	25 628 00	359 00	25 269 00	98 6	86
18	16 892 00	1 250 00	15 642 00	92 6	79 6
19	7 275 00	7 00	7 268 00	99 9	79 5
20	3 148 00	179 00	2 969 00	94 3	75
		\$12 474 00			

\* It is assumed that all additions are made on July 1 and all retirements on June 30 except those retirements occurring in the year of installation which are assumed to be made on September 30 (at age of 1/4 year)

Fig 18 Data for Composite Original Group Method

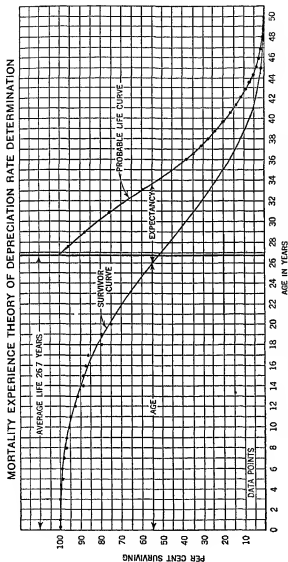


Fig 19 Survivor and Probable Life Curves (Based on Fig 18)

Age in Years	Renewals of Original Units during Year 1 following Given Ages—Per Cent	Survivors at Given Ages—Per Cent	Partial Areas under Curve Service Percent Years	Remaining Service Per cent Years	Expectancies in Years	Probable Life in Years
(1)	(2)	(3)	(4)	(5)	(6)	(7)
0	1	100	40.75	558.25	5.63	5.65
1/2	2	99	98.00	513.50	5.10	5.00
1 1/2	3	97	95.50	415.50	4.28	3.78
2 1/2	0	94	89.50	320.00	3.41	2.91
3 1/2	13	85	78.50	239.50	2.77	2.27
4 1/2	21	72	61.50	152.00	2.11	1.61
5 1/2	17	51	42.50	90.50	1.77	1.27
6 1/2	13	34	27.50	48.00	1.41	1.01
7 1/2	11	21	15.50	20.50	0.98	0.48
8 1/2	10	10	5.00	5.00	0.50	0.00
9 1/2		0				
			563.25			

Fig. 20 Life Expectancy Data for Physical Property

height of each age ordinate will be made available. Fig. 20 illustrates method of subtotaling these strip areas for the curve of Fig. 17. Starting at the bottom of the table, which corresponds to the right end of the mortality curve, the area of the first strip between  $8\frac{1}{2}$  and  $9\frac{1}{2}$  years is equal to  $\frac{100+0}{2} = 5$  percent-years. The area of the next strip between

$7\frac{1}{2}$  and  $8\frac{1}{2}$  years is  $\frac{21+10}{2} = 15.50$  percent-years, etc. up to the extreme left strip between 0 and  $\frac{1}{2}$  year which is only  $\frac{1}{2}$  year wide. The area of this strip is  $\frac{100+99}{4} = 49.75$  percent years. The values for

all the strips are shown in column (4) of the table, and the cumulative subtotals of these strip areas are given in column (5). Life expectancies for the various ages are given in column (6) and were obtained by dividing the area in the subtotal area column by the corresponding survivors. Probable life may be defined as

Attained age + Expectancy at that age

Carroll shows graphically the relationship of average life, expectancy, and probable life to each other (Fig. 19). He states (NACA Bulletin, vol. 23)

It might be important to mention here that as equipment gets older the portion of it which remains in service logically has a life expectancy less than that of new equipment. Beginning with the average service life which is the life expectancy of new equipment, a curve indicating the expectancy of older equipment can be plotted by determining the average service life at each age in the same manner as for new equipment. The curve can then be drawn through the several points thus obtained, indicating the total probable life of plant at any age as shown by the survivor curve. The horizontal distance between the survivor curve and the probable life curve at any point is the life expectancy of the equipment at that particular age. This feature may add complications, but it is important in computing the average life of old equipment.

**ANNUAL RATE METHOD**—In this method observations need only be made for a period of years such as one, two three five or ten years. The period selected should be a normal period thus giving representative retirement or replacement rates. The ideal period is one so short that it only reflects present policies and standards, and yet long enough so that numerous replacements will have been made at each age of property in existence. Carroll refers to this method as the **multiple original group method**. The steps in computing the annual retirement rates based on several years' observations, according to Kurtz, are

- 1 Determine average number of units retired each year
- 2 Determine average number of units of each age group in service each year
- 3 Retirement rate equals item 1 divided by item 2

**TURNOVER METHOD**—As stated by Carroll, cited above

This method derives its name from the fact that the average service life is assumed to be the number of years required to turn over by retirement and replacement a given number of dollars invested in plant which was in service on a particular date.

The simple turnover method consists of an accumulation of retirements of plant backwards chronologically, from a certain date until the accumulations equal the property in service at an earlier date. The number of years of retirements necessary to attain this result is the turnover of the plant. What is indicated is the average life of all the property, this method does not establish the life expectancy of property in service at any time unless life characteristics have remained unchanged.

## Depreciation Rates

### DEPRECIATION PRACTICES AND RATES—Information

**Treasury Decision 4422**—As the income tax rates have risen the deduction for depreciation has assumed a greater importance in the calculation of taxable net income, and the Treasury has ruled that detailed records of fixed assets must be kept. Blanket or composite depreciation rates do not provide accurate costs, fail to fix responsibility and do not give the necessary details of the depreciation charges and reserves. In connection with the passage of the 1934 Revenue Act, it was decided

that past allowances for depreciation had been excessive and that the taxpayer must prove the reasonableness of his depreciation deductions. This led to the issuance of Treasury Decision 4422 which states:

The deduction for depreciation in respect of any depreciable property for any taxable year shall be limited to such ratable amount as may reasonably be considered necessary to recover during the remaining useful life of the property the unrecovered cost on other basis. The burden of proof will rest upon the taxpayer to sustain the deduction claimed. Therefore taxpayers must furnish full and complete information with respect to the cost or other basis of the assets in respect of which depreciation is claimed, their age condition and remaining useful life, the portion of their cost or other basis which has been recovered through depreciation allowances for prior taxable years and such other information as the commissioner may require in substantiation of the deduction claimed.

Mimeograph 4170, issued as a supplement to TD 4422, lists four points to be covered in the information to be submitted by the taxpayer: (1) cost, (2) basis, (3) age and amount recovered, and (4) "such other information as may be required to establish the correctness of the deduction claimed or to determine the amount of the deduction properly allowable."

In cases where the detailed property records are not sufficient to determine the correct depreciation deduction, the Mimeograph provides that assets must be grouped by accounts having approximately the same average lives. This will make possible the determination of satisfactory yearly deductions. The depreciation schedule accompanying Mimeograph 4170 is designed to give the maximum information for analysis of the assets, the deductions, and the valuation reserve. The information required is as follows:

Account  
Original estimated useful life  
Depreciation rate  
Year acquired  
Original cost and subsequent additions by years including current year  
Deductions for sales and other dispositions in prior years  
Adjusted cost at beginning of year  
Credits to Depreciation Reserve, prior years (depreciation allowed or allowable)  
Charges to Depreciation Reserve, prior years (other than retirements or sales)  
Depreciation Reserve, beginning of year  
Balance remaining, beginning of year  
Estimated remaining life  
Deductions for sales and other dispositions current year  
Adjusted cost end of current year  
Charges to Depreciation Reserve current year  
Net Depreciation Reserve, end of current year

The taxpayer is not required to use the schedule given, but may substitute any other that will give the required information. The emphasis is upon the accounting for the asset cost and the depreciation deduction claimed.

The net effect of the Treasury rulings is to eliminate the use of composite depreciation rates. A detailed plant ledger should be established and used as the base for a recording of asset costs and to substantiate depreciation deductions.

**Regulation S X**—The Securities and Exchange Commission has adopted a uniform set of accounting requirements applying to the form and content of all financial statements and schedules required to be filed as a part of

- a Registration statements under the Securities Act of 1933 filed on Form A-2
- b Application for registration of securities under the Securities Exchange Act of 1934 filed on Form 8-A 8-B, 10, 11 13 14 15 17 22 23 or 24
- c Supplemental or periodic reports under Section 13 of the Securities Exchange Act of 1934 notably 10-K's
- d Supplemental or periodic reports under Section 15 (d) of the Securities Exchange Act of 1934 filed on Form 1-MD or 4-MD

Rule 319 of Article 3 (Rules of General Application of Regulation S-X) reads as follows

Rule 319 (c) Depreciation depletion obsolescence and amortization State the policy followed during the period for which profit and loss statements are filed with respect to—

1 The provision for depreciation depletion and obsolescence of physical properties or reserves created in lieu thereof including the methods and if practicable, the rates used in computing the annual amounts

2 The provision for depreciation and amortization of intangibles or reserves created in lieu thereof including the methods and if practicable the rates used in computing the annual amounts

3 The accounting treatment for maintenance repairs, renewals and betterments and

4 The adjustment of the accumulated reserves for depreciation depletion obsolescence amortization or reserves in lieu thereof, at the time properties are retired or otherwise disposed of

The Commission desires a detailed treatment and accounting for depreciation, and today all listing corporations are following the prescribed forms

The requested information in effect requires the compilation and keeping of an adequate plant ledger This plant ledger must conform in detail with the information shown on the Schedule under Rule 1207 (See discussion of Plant Ledger earlier in this Section )

**Studies by Bureau of Internal Revenue**—An extensive compilation of depreciation data is found in Bulletin "F" prepared by the Bureau of Internal Revenue as a general guide for tax purposes In the original bulletin the experience data were shown in the form of annual rates but in the revised edition average service lives are listed, a more satisfactory method of presentation The introductory statement for Part II containing depreciation data is as follows

A reasonable rate for depreciation is dependent not only on the prospective useful life of the property when acquired but also on the particular conditions under which the property is used as reflected in the taxpayer's operating policy and the accounting policy followed with respect to repairs maintenance replacements charges to the capital asset account and to the depreciation reserve If the useful life of the various assets shown hereafter could be determined precisely which cannot be done there still could not be established standard rates of depreciation unless there existed standard methods of operation and of accounting from which there could be no deviation

Being based on the usual experience of property owners the probable useful lives shown herein for each kind or class of assets are predicated on a reasonable expense policy as to the cost of repairs and maintenance. Therefore, in the determination of the depreciation allowance in each case due consideration should be given the maintenance and replacement policy of the taxpayer and the accounting practice regarding the same.

The estimates of useful life set forth herein are for new properties only. In applying them consideration should be given to salvage values to that portion of the service life already expired and to that portion of the cost previously recovered or recoverable through prior depreciation deductions or other allowances.

It has been found that normal obsolescence is a very important factor in determining the useful life of property. The estimated useful lives shown herein include an allowance for normal obsolescence but do not contain any provision for extraordinary obsolescence, such as is occasioned by revolutionary inventions, abnormal growth or development, radical economic changes, or other unpredictable factors which may force the retirement or other disposition of property prior to the termination of its normal useful life.

In this compilation are listed for each industry the useful lives of various assets including wherever practicable lives for composite accounts and group accounts. The lives for buildings and building equipment, power generating equipment, office equipment and motors and other vehicles are shown separately and unless specifically mentioned in the text these assets are not included in the composite lives indicated herein. All lives are given without fractional years. In practice, however, fractions may be used.

The tabulation of service lives of equipment is arranged by industries and covers about 65 printed pages. For some industries only general data are given, in other cases average lives are shown in detail by classes of equipment. The following excerpts are illustrative.

## **AUTOMOBILE INDUSTRY**

### **MANUFACTURING**

The average life of the machinery varies from 15 to 20 years and tools, dies, patterns, etc., generally have an average life of from 3 to 4 years. Most of the equipment used by automobile manufacturers is of standard metal and woodworking design and items for this class of equipment can be taken from the list pertaining to fabricators of metal and wood.

### **ACCESSORIES**

The remarks applying to the automobile manufacturing industry apply also to a considerable extent to the manufacturers of accessories. In general, however, the machinery has an over-all composite life of 15 years.

### **REPAIR SHOPS**

The average composite life of machinery for automobile repair shops has been found to be approximately 10 years.

### **BAKERIES**

In general, it has been found that the composite life of 12½ years applies to cake bakeries, 14 years to bread bakeries, and 20 years to biscuit manufacturers. The item lives applicable to the baking industry are set forth in the following tabulation, some adjustment being needed, depending upon the type of bakery in which the assets are used.

## AVERAGE USEFUL LIFE (YEARS)

Ballers dough	15	Mixers	
Beaters		Cookie and cake three spindle	25
Light	10	Dough fire barrel—	
Heavy	15	High speed	20
Bins flour storage		Slow speed	25
Steel	33	Vertical dough three and four	
Wood	25	sped	
Brakes dough	15	Light	15
Burners gas or oil	15	Heavy	20
Cake machine open saddle	20	Molders	
Cases for shipping, bread (inventory)	2	Dough	12
Cleaners sack	15	Roll	12
Cutting machines	20	Ovens	
Conveyors		Automatic or traveling	17
Belt	17	Band type	20
Chain and flight cake	20	Brick peel	20
Panning	20	Portable peel	20
Flat apron bread	25	Reel	20
Sprial screw	25	Rotary	15
Cookers doughnut	15	Stationary	25
Coolie machines wire cut	17	Palers	15
Cooler and paler	15	Pan greasers and cleaners	10
Cooling equipment	20	Pans—baking	6
Cracker cutting machines	15	Paring machines	10
Cracker peeling machines	15	Peeling machines	15
Cracker machines	15	Perforating machines	15
Cutter—wafer	15	Pie clippers and trimmers	15
Cutting and panning machines	25	Pie rolling machines	15
Depositors—cake	15	Pretzel cooling machines	10
Dies rolls, and cutters	10	Ploofers	15
Dividers—dough		Pulverizers sugar	20
Hand	20	Reels bolting	15
Power	12	Refining machines chocolate	20
Doughnut machines automatic	15	Refrigerating equipment (See	
Droppers		Ice manufacture and refrigeration)	
Cake	15	Refrigerators	15
Cookie	20	Roller pie crust	15
Dryers, special cookie	20	Rounding machine dough	15
Elevators flour bucket or pan and tray	20	Rubbing and creaming machines	20
Elongator	20	Sack cleaners	15
Embossing machine, biscuit	20	Sandwich machine	15
Emober	20	Scales automatic — Flour or water	15
Fans	15	Sealer	15
Forming and stitching machines carton	15	Sheeters	15
Fruitana machines	20	Sifters flour sugar, starch etc	17
Gluing machine	15	Slicers bread	12
Grinding machines	15	Spreader sugar wafer	20
Humidifiers	15	Tables sorting	20
Ice boxes	15	Tails	
Iceing unit	15	Galvanized iron	15
Kettles—copper plated		Glass, enameled lined	25
Chocolate melting	25	Steel	25
Marshmallow	15	Tempering and measuring	15
		Wood	15



## AVERAGE USEFUL LIFE (YEARS) (Continued)

Tape moistening machine	15	Troughs dough	25
Thermometers		Trucks bowl bread or pan	20
Mercury column	5	Wafer machines, automatic	20
Recording	10	Wrapping machines	15
Topping machines	20		

For each industry an estimate of the average composite life for all classes of equipment is given

**ACCELERATED DEPRECIATION**—An NACA research study (vol 22) defines accelerated depreciation as

a blanket increase in rates during a period of abnormal activity to take care of the additional wear and tear occasioned by more than normal usage of equipment. It should be distinguished from adjustment of rates resulting from a review of estimated remaining life as required by T D 4422

When depreciation is applied on the basis of output or service hours an automatic increase takes place since the depreciation charge is proportional to the units produced or hours worked. The question of acceleration therefore relates largely to companies using the straight-line basis. In 1941 some, though not many, companies had increased their depreciation rates due to production increases over normal. There was, however, no uniformity in the rate increases suggested. Accelerated depreciation becomes an active issue when plant facilities are operated intensively during emergency or war conditions. The Treasury Department recognizes that the effect of operating two or three shifts per day instead of one may entitle a taxpayer to accelerated depreciation, but is inclined to place the burden of proof on the taxpayer, particularly where past experience shows that obsolescence has been more potent than wear and tear in bringing about retirements.

In discussing cost accounting for war contracts Jackson (Michigan Business Papers No 13) writes

The government regulations seem to recognize the validity of increasing the normal charge for depreciation if operating conditions result in increased use of machinery and equipment but no definite basis has been established by most departments by which a contractor can be aided. The Navy Department has apparently agreed that under certain conditions rates for machinery and equipment may be increased to 150% and 200% of normal. The Treasury Department, however, is actively opposing increases for tax purposes.

The present tendency is for taxpayers to rely on T D 4422 that "any claim for depreciation should be determined upon the conditions known to exist at the end of the period for which the return is made."

**Use of Activity Factor**—Reno (Journal of Accountancy, vol 74) recommends the modification of straight-line depreciation procedure through the application of an "activity factor." The following is adapted from this writer's discussion

Life expectancies are determined just as if straightline depreciation were to be employed. The next step is the making of an estimate of normal or average production (an estimate subject to revision from time to time). Actual production is compared with normal production and the activity factor or percentage determined. This factor is then applied to depreciation for the year computed on the straight line basis, with consequent increase or decrease of such depreciation. The result is often accomplished by adopting a table of depreciation rates for various levels of production.

If the exact activity factor is applied to normal depreciation, the resulting depreciation is virtually on a unit of production basis. However in most cases the application of the factor is limited. For example a ceiling may be set at 150% and a floor at 50% of normal straight line depreciation. Another possibility is to adjust the activity factor as originally computed according to some definite procedure, thus if production is 20% above normal the increase in depreciation might be limited to one half this increase, or 10%.

**COMPOSITE RATES**—A composite rate is one based on the average life of a plant. More specifically, according to Carroll (N A C A Bulletin, vol. 23)

The composite life system contemplates depreciation as a unit a number of mixed assets assembled to perform a particular service but with each such unit having a different life expectancy. A simple illustration would be that of a filling station with building structures and runways taking one rate, tanks and pumps another, grease racks perhaps another, and office equipment still another.

According to Taylor and Miller (Intermediate Accounting) the composite life

permits a single rate to be applied to the total investment in all depreciable assets of varying useful lives. The average life of all depreciating assets is determined by grouping them into what may be called life classes.

The computation below illustrates the method.

(1) Life Expectancy Group	(2) Original Cost	(3) Salvage Value	(4) Cost Less Salvage	(5) Depreciation per Year
5	\$ 12 000	\$ 1 000	\$ 11 000	\$ 2 200
10	50 000	7 000	43 000	4 300
15	40 000	4 000	36 000	2,400
18	31 000	4 000	27 000	1 500
	<u>\$133 000</u>	<u>\$16 000</u>	<u>\$117 000</u>	<u>\$10 400</u>

$$\text{Composite Life} = \frac{\$117\,000}{\$10\,400} = 11.25 \text{ years}$$

$$\text{Composite Rate} = \frac{\$10\,400}{\$133\,000} = 7.82\%$$

In the above illustration, in 11.25 years there is written off 11.25 × 7.82%, or 87.97% of the total cost. This is equal to the total depreciable value as shown in column (4) above, since

$$\$117\,000 - \$133\,000 = 87.97\%$$

The following comments on composite or blanket rates are quoted from Bulletin "F" of the Bureau of Internal Revenue:

All depreciable assets are included in one account with a single depreciation reserve. In computing depreciation an overall composite rate is applied to the cost or other basis of all depreciable property. The depreciation rate is determined by applying the appropriate component rate to the cost or other basis of each classification or group included in the composite account and dividing the total amount thus obtained by the total cost of all depreciable property. Under this method it is necessary to redetermine the composite rate whenever substantial changes occur in the relative proportions of different groups of assets. The method has the merit of extreme simplicity in application and if the rate is adjusted to material changes in composition of the plant account it is acceptable.

Saliers (Depreciation Principles and Applications) says that composite depreciation should be abandoned.

Even where average or composite rates can be successfully employed it will usually be found that equivalent or more satisfactory results can be secured where a detailed plant record is kept at no greater cost.

**UNIT RATES**—Unit rates are closely connected to the maintenance of property records through unit control (see earlier discussion). Plant accounts are kept for each unit and the corresponding reserves accumulated on each stock ledger card. At retirement, all information required by the accountant is available from the unit record (Fig. 12). Under the unit rate system, separate depreciation rates are established for each unit. However, the system becomes unwieldy where there are many small units.

**GROUP RATES**—Group rates in effect are special types of composite rates. According to Carroll (NACA Bulletin, vol. 23), the group system assumes

1. An aggregation of homogeneous depreciable units
2. Determination of depreciation periodically for the entire group of assets as though it were a unit
3. Maintenance of a single depreciation reserve account for the group

Grouping of assets according to Carroll may be horizontal, vertical, or geographical. In horizontal grouping all assets of like physical characteristics, such as tanks, locomotives, auto trucks, etc., are grouped together. Vertical or functional grouping includes all assets aiding in the performance of a common aim, such as those of a paper mill, a refinery, etc. Geographical grouping consolidates the assets of a district or region into one unit. The group system of depreciation is fairly popular. A 1941 research study (NACA Bulletin, vol. 22) reports that of 245 companies, 65 use this method for all their assets and 62 use it for a portion of their assets.

**Selection of Groups**—The first task is to determine the size and nature of the groups. Concerning the latter, the aim is to create homogeneity. As to size, the larger the number of units composing the group, the more stable and reliable becomes the average life of the group and hence the group rate. Economic conditions or income tax considerations sometimes determine the nature of the grouping. Carroll states

For example the district equipment in an oil field which may be depleted before the equipment is worn out probably should form one group. This method of grouping has two advantages over the horizontal group

- 1 It provides a more natural base for cost distribution
- 2 The Bureau of Internal Revenue allows a retirement loss only when all the equipment within the group is abandoned. In a horizontal group of pumps for example no loss could be claimed until the company had retired all the pumps wherever located.

Another consideration in group selection is the need for a fair distribution of costs. In this connection Carroll writes

It is possible to use such large and all inclusive groups that the distribution of depreciation charges is arbitrary. Sometimes as in the case of cost plus contracts and joint operating agreements, cost distributions have more than ordinary significance and great care should be exercised in designing a plan for depreciation distribution. Indeed it may be that rushing all doing into a group system under such conditions would result in the maintenance of additional supplementary depreciation and cost records in accordance with the provisions of the contracts. It is believed that benefits derived from a reduction of clerical work elsewhere might be more than offset by the duplication of work in such cases.

**Operation of Group System**—In starting the system, the cost of all fully depreciated assets is eliminated from the group depreciation base. Only one reserve account is kept for each group and depreciation is charged at the weighted average rate on the entire group investment. As a result depreciation may be accumulated to an amount greater or smaller than the original investment in a unit, upon retirement, normally the entire cost is charged against the group reserve.

Fig. 21 shows a group plant record for three classes of pumps, each class having a different depreciation rate. The form provides for a complete columnar analysis of the group depreciation reserve. The weighted average rate is computed by calculating the depreciation separately on each class and expressing the total as a per cent of the total cost. The monthly provision (1/12 of the annual amount) is computed on the opening balance of the investment, hence the journal voucher for depreciation may be put through as early in the month as desired. Additions are entered in the investment column, retirements in the investment and group reserve columns. In each case the annual depreciation column is adjusted so that new monthly totals may be computed.

In ordinary retirements, the full cost is charged to the group reserve and also the removal cost. Salvage is credited to the reserve. The retirement of August 17 is, according to Carroll assumed to be extraordinary, and only the accumulated depreciation is charged to the reserve.

**Conclusions Regarding Group System**—Group rates must be closely watched and adjustments made when existing rates produce group reserves that seem to be out of line. Carroll cites among others the following conclusions

- 1 The system provides reliable depreciation costs and reserves provided
  - a Groups are homogeneous
  - b Rates are accurate
  - c Sufficient detail is maintained for continuous analysis and revision of group rates

## PUMPS AND PUMPING EQUIPMENT

Date	INTERESTMENT			Rates	Annual Depreciation	GROUP DEPRECIATION RESERVE							Direct Profit (Loss) Items
	Balance	Additions	Deductions			Balance at Beginning of Period	Additions		Deductions				
							Current Provision	Salvage on Retirements	Other	Retirements	Dismantling Cost	Other	
8-1-41	\$ 26,500 00	\$	\$	\$	6.20%	\$ 2,263 00	\$	\$	\$	\$	\$	\$	\$
8-1-41	58,200 00				8.75	3,246 50							
8-1-41	72,800 00				8.40	6,073 20							
3-16-41	\$167,000 00	\$ 18,450 00	\$	\$	7.00%	\$11,682 70	71,637 00	973 56					
3-16-41					8.75	1,000 88							
3-17-41					6.20	(826 20)		310 00		10,100 00	150 00		
3-31-41					9.48	(2,100 00)				17,870 00			
1-41	\$180,350 00	\$	\$	\$	6.66%	\$10,017 38	44,890 56	834.78				44,890.56	*(7 40L00)

\* Extraordinary retirement due to fire.

Net Book Value  
Removal Cost  
Total  
Salvage  
Loss

\$7 130 00  
1 951 00  
\$8 381 00  
890 00  
\$7 491 00

Fig 21 Group Plant Record

- 2 The size of groups depends upon
  - a Operating conditions
  - b Climatic conditions
  - c Products manufactured
- 3 Internal Revenue Department favors this system for concerns having large numbers of similar properties
- 4 Recent scientific methods of rate determination appear to have been developed in connection with the group system
- 5 The group system may be used simultaneously with unit and composite rate systems within one plant

## Apportioning Depreciation

**GENERAL PRACTICE**—The great majority of businesses charge depreciation by the straight line method or some variant thereof. These are the simplest and easiest methods. Fabricant made an exhaustive analysis of private and public capital accounts and presented his findings in *Capital Consumption and Adjustment* (National Bureau of Economic Research, 1938). Fig. 22 taken from this source shows the depreciation and other practices followed in accounting for expenditures on durable capital goods. The table was compiled from material obtained from individual reports to the Securities and Exchange Commission on Form 10 and from a few published reports compiled by the Standard Statistics Corporation. The figures indicate the number of corporations reporting each practice. An analysis of the miscellaneous methods shown in the last column of Fig. 22 is as follows:

	Number of Companies
<b>Cost charged to current expenses in the case of</b>	
(a) Intangible development costs (mining)	6
(b) Patents research etc	12
(c) Tools dies forms etc	13
(d) Leaseholds	2
(e) Other	1
(f) Flat sum in lieu of detailed estimate	6
(g) Maintenance basis	8
(h) Inventory basis	9
(i) Lapsing method	1
(j) Diminishing balance method	9
(k) Service output method and constant sum	6
(l) Straight line method modified by % of normal activity	7
(m) Straight line method (10%) until reserve is 75% of cost, thereafter 20% of residue	1
(n) Fifty per cent written off utensils first year thereafter no depreciation charge	1
<b>No depreciation charge if</b>	
(o) Idle or outside property	11
(p) Fully depreciated property	3
(q) Offset by appreciation	2
(r) No explanation	3
	<u>101</u>

	Depreciation by Straight Line Method				Depreciation by Service Output Method	Other
	Total in Sample	Implicitly Indicated	Explicitly Stated	Total		
INDUSTRIAL GROUP						
Mining	27	10	12	22	7	3
Manufacturing	373	180	172	352	51	91
Construction	7	4	3	7		1
Trade	41	26	13	39		6
Service	13	6	6	12		
Grand total	460	226	203	432	58	101
MANUFACTURING SUBGROUPS						
Foods	41	20	13	28	3	4
Beverages	12	4	6	12		1
Tobacco	11	3	6	9	1	1
Textiles	27	10	17	27		3
Leather	6	2	3	5		3
Rubber	10	2	8	10	1	1
Lumber	5	2	2	4		1
Paper	12	6	5	11	3	1
Printing and publishing	7	4	3	7		1
Drugs	12	6	6	12		1
Petroleum	27	13	14	27	13	6
Chemicals	26	14	12	26	3	6
Stone, clay and glass	16	6	9	15		4
Iron and steel	23	10	8	18	14	9
Nonferrous metals	13	5	8	13	1	4
Machinery	47	23	16	44	2	17
Automobiles and accessories	23	20	8	28	6	6
Miscellaneous metals	32	17	13	32	1	11
Miscellaneous manufacturing	14	8	6	14	2	5
Total manufacturing	373	180	172	352	51	91

Fig 22 Depreciation Methods Used in Industry

In view of the facts shown by Fig 22, only those methods of apportioning depreciation which are in common use need be discussed. These are

- 1 Straight Line
- 2 Service Output
- 3 Productive Hour
- 4 Declining Balance

**STRAIGHT LINE METHOD**—Under this method the total depreciable amount is spread in equal amounts over the life span of the asset, the amount is ordinarily expressed as a per cent of cost. Thus, if

$C$  = Cost

$S$  = Scrap value

$n$  = Number of years

$d$  = Amount of annual depreciation

$r$  = Rate of annual depreciation

$$\text{Then } d = \frac{C - S}{n}$$

$$r = \frac{d}{C}$$

For an asset costing \$1,500 with an estimated salvage value of \$300 and an estimated life of twelve years

$$d = \frac{\$1,500 - \$300}{12} = \underline{\underline{\$100}}$$

$$r = \frac{100}{1,500} = 6\% \%$$

In practice the salvage value is often disregarded, and the depreciation rate is therefore found by dividing the number of years into 100. A ten-year life represents a 10% rate, a twelve-year life 8⅓%, etc.

**Appraisal of Straight-Line Method**—The method is simple and the rates are easily calculated, and easily adjusted where adjustment becomes necessary. Its basic assumption is that depreciation is a function of time which is true of the depreciation due to lapse of time and of obsolescence, but not that portion due to wear and tear. It is undoubtedly the most widely used method, most experience tables being based on straight-line rates. Finally, it is approved for income tax purposes. Bulletin F states

Ordinarily depreciation computed by this method represents the actual diminution in service value from year to year as closely as the depreciation computed by any other method. The practical simplicity in accounting records required and the ease and facility by which revisions or changing life estimates may be applied tend to make this method the most acceptable one for general use.

On the other hand, the straight line basis is often objected to on the ground that it does not take into consideration intensity of use. It constitutes a true fixed charge. From a financial viewpoint it may be desirable to ease the burden in periods of subnormal activity, though accountants in principle object to such practice. Another objection is based on the fact that as the asset grows older, the fixed depreciation charge plus the increasing maintenance charges matched against the



falling revenues create an intolerable situation. However, as Paton says (Advanced Accounting)

The plant property of the typical industrial concern is represented by many units in various stages of service life, rather than by a single asset.

In this way, other things being equal, revenues and charges tend to become stabilized.

**PRODUCTION METHODS**—The underlying principle of all production methods is that they make depreciation a use function rather than a time function. They create a variable in place of a fixed charge for depreciation, that is they charge depreciation in proportion to plant activity. Essentially, all production methods are variations of the straight-line method. If production expressed either in units of output or in working hours is uniform the results if plotted, are a straight line. The principal types of bases for apportionment which have been suggested in this connection are as follows:

- 1 Total units of product or service
- 2 Total operating time
- 3 Volume of sales
- 4 Jobs or orders undertaken

The first of these involves an estimate as to the total number of units of product to be turned out or contributed to by the particular asset, and it is evident that in relatively few cases can such an estimate be anything more than a guess. Operating or active time is often a simpler and sounder basis than physical output. Volume of sales is relatively unsatisfactory as a basis for apportionment, particularly in view of the fact that the value of the product for any considerable period is even more difficult to estimate than amount of output and that final gross revenues do not as a rule attach to the particular machine or other unit of property in any definite way. The job or order as a basis for apportionment is useful primarily in fields where particular assets are largely consumed on a particular job, as sometimes happens in the building trades or in shipyards, and in other special cases. The Bureau of Internal Revenue recognizes the propriety of the "job method" for writing off the cost of "single-purpose or special-purpose equipment."

The production methods like all other schemes of apportionment require the fundamental estimate of service life and in this estimate must be considered such factors as obsolescence and inadequacy as under the straight-line plan.

**Service Output Method**—Under this method depreciation is made to vary with the number of units produced. If it is possible to express the expected production of a unit of equipment with reasonable accuracy, this method becomes feasible. Thus, it is possible to calculate depreciation in the case of linings of blast furnaces on a unit output basis. Bulletin F (Bureau of Internal Revenue) points out that the method is particularly applicable in the case of natural resources where the available reserves which limit the useful life of property can be foretold with reasonable accuracy.

To apply the method, the cost of the property (or cost less estimated salvage value) is divided by the number of units, thus producing a unit

cost. The depreciation in any period is simply the number of units multiplied by the unit cost.

The same source comments on the utility of this method. The chief reason why natural resources furnish a good example of application of this method is that "the rate of production measures the rate of exhaustion of the property." The bulletin states:

For most property it is not possible to obtain this information with any reasonable degree of accuracy and, therefore, the method is not considered an acceptable one for general application to the machinery account of industrial concerns or to the property of those companies exploiting a natural resource with reserves sufficient to extend operations beyond the physical life of the original plant.

**Working Hours Method**—The number of hours, for example, that a particular machine will run at a given speed and with standard conditions of maintenance can be estimated in some cases on the basis of operating experience. Thus it is possible, for example, to estimate the flying hours of an airplane motor with some degree of accuracy. In making such estimates consideration must be given, however, to the problem of total useful life in view of all the circumstances, and to the factor of idle time. Where this general plan is adopted the usual procedure is to determine a depreciation cost per active hour and the depreciation in a given period is the hour-rate times the hours operated in the period. Naturally it is necessary when using this method to maintain complete operating records.

The method is quite similar to the service output method. The life of the asset is expressed in terms of working hours instead of years and a unit cost is obtained per working hour. By maintaining adequate records of machine operation, it is then possible to compute the periodic depreciation charge multiplying the number of hours by the hourly rate.

**Appraisal of Production Methods**—The production methods as contrasted with the straight-line method represent opposite extremes of depreciation accounting. The former make depreciation a 10% variable charge while the latter treats depreciation as a 100% fixed charge. Wherever applicable, the production methods offer a fairly easy method of applying depreciation. On the other hand there is the danger of underdepreciation in periods of subnormal activity. In the extreme case, no depreciation is charged when the plant is completely idle. This of course is absurd as well as dangerous. The production methods emphasize intensity of use to the total exclusion of the other factors present in the depreciation function.

**OTHER MODIFICATIONS OF THE STRAIGHT-LINE METHOD**—A compromise between the straight line and production methods is obviously called for. This consists of recognizing a fixed minimum charge for depreciation which is present at all levels of activity from zero to 100%. Superimposed upon this is a variable charge based on service output or working hours. Reference to Fig 21 shows that this method is only moderately popular being used by thirteen companies in the sample studied, if items (k) and (l) are considered as amounting to about the same thing. However, some of the most progressive concerns have begun to introduce this method, it offers in many ways an ideal solution to the depreciation problem.

**DIMINISHING BALANCE METHOD**—Fig 22 shows nine companies to be using the diminishing balance method with an additional company using it in connection with the straight-line method. In the latter case, straight line depreciation was applied until 75% of cost was accumulated in the reserve, thereafter, a rate of 20% was applied to each year's remaining book value. There are a number of variations of the declining balance method.

- 1 Declining balance, scientific.
- 2 The fractional or weighted year method.

**Declining Balance, Scientific**—The formula for the determination of the necessary percentage may be stated as follows:

$$r = 1 - \sqrt[n]{\frac{S}{C}}$$

In this equation  $r$  is the required percentage,  $n$  the number of periods,  $S$  the net salvage value, and  $C$  the cost on other basis. Thus assuming that an asset costing \$100 has a service life of 25 years and a scrap value of \$1, the application of the formula yields the following results:

$$r = 1 - \sqrt[25]{\frac{1}{100}} = 1.68236 \text{ or } 16.8236\%$$

The depreciation for the first year is then \$16.82, leaving a net book value of \$83.18. The depreciation for the second year is \$13.99 (i.e., 16.8236% of \$83.18), which yields a new book value of \$69.18, etc.

Fig 23, adapted from *Saliers (Depreciation Principles and Applications)*, illustrates the method graphically and compares it with the results obtained from the use of the straight-line method. The graph presents the accumulations in the Reserve for Depreciation account under both methods. The declining balance method is sometimes referred to as the asymptotic method, since the curve approaches the

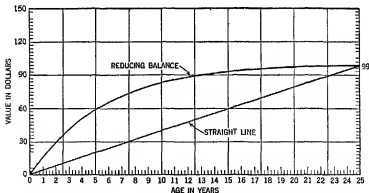


FIG 23 Comparison of Reduced Balance and Straight Line Depreciation

cost as an asymptote. If instead of plotting the accumulations in the reserve, the successive book values are plotted, the curve is reversed, and becomes asymptotic to the scrap value.

**Fractional Year Method**—This method also referred to as the weighted year method, or the sum of expected life-periods method, consists of applying depreciation by means of a series of fractions the numerator of each of which represents the life expectancy at the beginning of each period and the denominator represents the sum of all the numerators. For example

An asset has an expected life of 5 periods or successive period life expectancies of 5, 4, 3, 2, 1 a total of 15. Taking the successive life terms as numerators and the total as the denominator gives changing depreciation rates for the 5 years of  $5/15$ ,  $4/15$ ,  $3/15$ ,  $2/15$  and  $1/15$ . Assuming a cost of \$110 and a net salvage of \$10 the use of these rates gives successive depreciation charges of \$33.33, \$26.67, \$20.00, \$13.33, and \$6.67.

The only argument supporting such a method is that of conservatism. It provides for heavy depreciation charges during the early years of the life of an asset, when it may be assumed to be most productive, and lighter charges in the later and supposedly less productive years. The fact that maintenance charges tend to increase with age is sometimes pointed to as support for a decreasing charge procedure in accruing depreciation. Such a procedure might be applied with some degree of reasonableness to assets such as motion-picture films, in which the life is short and amortization may be conceived as taking a continuously accelerated course. On the whole these methods have little practical value and their extensive adoption cannot be expected.

Bulletin "F," issued by the Bureau of Internal Revenue, includes this statement regarding the "declining balance method":

Its best application is to those accounts for property in which the greater proportion of the production is confined to the early part of the useful life.



## SECTION 23

### BUDGETS

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## SECTION 23

### BUDGETS

#### Basic Principles

**DEFINITION AND OBJECTIVES OF BUDGETING**—A budget is primarily a blueprint of a projected plan of action of a business for a definite period of time. Its fundamental purpose is to aid in securing control over the different parts of a business. This is done by comparing actual attainments against the budgetary figures and using the latter as a basis of comparison or yardstick in determining the efficiency of operations. These points are repeatedly mentioned by various authorities.

The primary purpose of budgetary control is to plan all operations so as to secure maximum profit from a minimum investment in working and fixed capital. (Cartmell N A C A Year Book, 1938)

Budgetary control may be defined as accounting in terms of the future. It means a careful planning of all functions of a business in advance. (Hilbert, Cost Accounting for Sales)

Budgetary control deals with the coordination of the several departments to the end that a well formulated program may be made for the business as a whole. (McKinsey, Budgetary Control)

A budgetary control system is a carefully worked out financial plan, including the procedure involved in its operations for coordinating the various divisions of a business for the ultimate purpose of earning a profit. (Van Sickle Cost Accounting)

To my mind a budget represents a standard a measuring stick with which to measure the accomplishment of the various activities of the business. (Crockett, N A C A Bulletin, vol 19)

In our practice we regard the purpose of the budget as one that will analyze the situation, develop the course our business is to follow and then assist management in controlling operations so that the desired objectives may be obtained or at least approximated. (Perry N A C A Bulletin vol 22)

Note that different objectives are emphasized by different authorities. In budgeting there are three objectives of primary importance:

- 1 Planning and forecasting which include the formulation of policies, detailed planning of future action and preparation of the best estimates possible of the effect of external influences on the business.
- 2 Coordination, which assures that a business shall be operated as a unified whole rather than as a group of separate departments.



- 3 Control which includes assignment of responsibility and measurement of results to the end that the forecasted profit goal may be attained

In practice an individual company may stress one objective more than the others. The statement has been made on several occasions by practical operating executives that they would still be in favor of budgeting if it involved nothing more than careful preparation of forecasts and plans. This statement has been used to stress the value inherent in planning and forecasting and the reduction of plans, policies, and forecasts to paper. In the large multiple unit company which is likely to lack cohesion, the principal value of the budget may be its coordinating influence, its ability to unite all elements in a business behind a unified plan of action. In other companies, and particularly in connection with costs, use of budgeted goals and allowances as a basis for control may be the primary objective of a budgetary control plan. Obviously, however, maximum results are obtained from a budgetary control set-up when all three objectives are striven for and achieved.

**ADVANTAGES OF BUDGETARY CONTROL**—The advantages accruing to a concern which has an established budgetary control procedure are summarized by Ernst and Ernst (*Budget Control What It Does and How to Do It*) as follows:

- 1 It has a marked influence on the most economical use of working capital since it is planned to make the maximum use of plant facilities and current assets.
- 2 It prevents waste since it regulates the spending of money for a definite purpose and in accordance with appropriations established by the executives of the business.
- 3 It places definitely just where it belongs, the responsibility for each function of the business.
- 4 It makes for coordination. It compels all departments of a business to cooperate in attaining the results fixed by the budget.
- 5 It presents in cold figures the best judgment of executives committed to a definite business objective, thus guarding against undue optimism which often leads to overexpansion.
- 6 It acts as a safety signal for management since it indicates the variance between estimates and the actual results obtained. Thus it shows when to proceed cautiously, as well as when manufacturing or merchandising expansion may be safely undertaken. It is an automatic check on the judgment of the executives, a check frequently revealing losses in time to stop the waste.
- 7 It is the most potent force in business for the conservation of the resources of business since it regulates the spending of money within the confines of income.
- 8 It is invaluable to management in determining the effect of sales production and financial policies.
- 9 It compels management to study its markets, products, methods and service, thus disclosing ways and means for strengthening and enlarging the business.
- 10 It compels management to study and to plan for the most economical use of labor, material and expense.
- 11 It is the only means for predetermining when and to what extent financing will be necessary.
- 12 It sets up a target to shoot at and provides a gauge for measuring the accuracy of the shot. It is a test of the ability of management to make things happen in accordance with a well ordered plan.

13 Managements which have developed a well ordered budget plan and which operate accordingly, find greater favor from their bankers and boards of directors

14 It compels management to fortify itself with adequate accounting, cost accounting, and financial records

**BUDGETING A MANAGEMENT FUNCTION**—Planning, co-ordination of activities and control are all parts of the management function. When these three are combined in a system of budgetary control, the budget becomes a tool of management which merits the support of the chief executive, department heads, and subordinates who place more reliance on it and give it a readier acceptance. Senou (N A C A Bulletin, vol 16) develops this point as follows

The president or general manager of the business should have direct control over all matters relating to the operation of the budget plan. It will of course be necessary for him to delegate most of the active work to subordinates but these assistants will act as his agents and will be directly responsible to him for the performance of the work so delegated.

With this arrangement the president is in a position to emphasize the importance of the budgetary program upon some department heads who might otherwise be inclined to underappreciate its value. Again differences of opinion and disagreements are sure to develop in the process of coordinating the programs of the several departments. Manifestly the president is the one and only executive who will be in a position to make the final decision relative to controversies between department heads of equal rank.

**BUDGET COMMITTEE**—In the development and administration of a budgetary control program the chief executive usually works through a budget committee and delegates primary responsibility for detailed operation of the budgetary program to an assistant, variously known as the budget director, budget officer, or assistant to the president. In a large manufacturing business, the budget committee is composed of the executives in charge of the major functions of the business and includes the sales manager, production manager, treasurer, and controller. In some cases the chief engineer, purchasing agent and various other officers or executives may be included. The chief executive may act as chairman of this committee and the budget director as secretary.

In smaller companies, budgeting is largely the responsibility of the accounting department acting for the chief executive. The committee type of organization is to be preferred because of the coordination of functions which results from meetings of the budget committee. Also greater cooperation is secured by making preparation and administration of the budget a democratic process in which all who share responsibility are given a part in the development of a comprehensive company-wide plan, in this way interest is aroused in seeing that the budget is so administered as to achieve the planned results. The principal functions of the budget committee are

- 1 To receive and review individual budget estimates
- 2 To suggest revisions
- 3 To decide on general policies affecting more than one primary department
- 4 To approve budgets and later revisions
- 5 To receive and consider budget reports showing actual results compared with budget
- 6 To recommend action where necessary

When functioning in this way, the budget committee becomes in fact a management committee and is a powerful force in knitting together the various activities of business, and enforcing real control of operations.

**BUDGET DIRECTOR**—While the controller, treasurer, and assistant to the president or an executive of the business with some other title may serve as budget director supervision of the budget is a separate and distinct function and not a division of work of the treasurer's, accounting or any other department. Logically, the budget director serves as assistant to the chief executive and this function should be shown as a separate function in the organization chart, even though the person performing this function has some other title, such as controller or treasurer. The following summary of duties of budget director is adapted from McKinsey (Budgetary Control)

- 1 To develop complete budgetary control procedure for the preparation and submission of budgets then approval handling of revisions and preparation presentation, and analysis of reports. This will include writing of instructions scheduling of due dates for each part of the work and the preparation of forms.
- 2 To see that accounting statistical and other departments supply data on past performance and expected future trends needed by department heads in preparing their budgets.
- 3 To receive estimates from department heads and transmit these to others whose budgets are dependent on or coordinated with them.
- 4 To prepare tentative forecasted balance sheets and profit and loss statements from departmental estimates and in consultation with the department heads involved, eliminate any discrepancies among departmental budgets.
- 5 To present departmental estimates forecasted balance sheets and forecasted profit and loss statements to the budget committee with his recommendations. These statements may well be on a comparative basis enabling members of the budget committee to compare forecasts for the coming period with the accomplishments of a prior period.
- 6 To supply the budget committee with all information needed to pass on, adjust and approve budgets.
- 7 To transmit to department heads the budget approved by the budget committee.
- 8 To make revisions or adjustments approved by the budget committee and transmit these to the department heads.
- 9 To receive from the accounting department all comparative reports of actual versus budgeted results and transmit them to department heads and the budget committee.
- 10 To transmit to department heads decisions and instructions of the budget committee arising from the committee's consideration of comparative reports.
- 11 To prepare such special analyses of budget performance for the chief executive budget committee and department heads as may be required.
- 12 In general to be constantly alert to discover new data and new methods which can be utilized to make the budgetary program more effective.

**RESPONSIBILITY FOR PREPARATION OF DEPARTMENTAL BUDGETS**—It is generally recognized that primary responsibility for departmental estimates rests with the departmental executives, with the budget director and the accounting department serving in

consulting capacities. Unless the executive in charge of a particular function prepares his own budget, the value which he gains from planning and forecasting his activity is lost, and his feeling of responsibility for achieving the goal set is greatly reduced. The accounting and statistical departments contribute data on past results and present trends, and, in the case of expense budgets, assist in the classification of expenses as fixed and variable. The budget director must develop forms and consult with and advise department heads. But each department head must accept the final responsibility for his budget, subject of course to such adjustments and modifications as may be decided upon by the budget committee. This last exception is important if the activities of the various departments are to be properly coordinated.

**LENGTH OF BUDGET PERIOD**—The establishment of a budget presupposes a period to be covered by the budget. Various departments of the business are subject to different influences and hence different periods may be used in budgeting the activities of the business. Capital additions, for example, may be planned ahead for a longer period than detailed operations. For example, the American Telephone & Telegraph Co. has a definite forecast of its business for ten years ahead and works towards that long-range plan. It assumes the telephone to be a permanent institution and subject to broad developments which can be studied by modern statistical devices.

In many cases the nature of the business determines the logical length of the budget period. For this purpose industrial companies may be divided into two broad classifications:

1. Companies which introduce new models each year, have definite style seasons or are very seasonal in their operations.
2. Companies which do not fall in any of the above three groups.

**Model Year, Style Season or Fiscal Year**—Companies in the first classification normally prepare budgets for the model year, style season, or fiscal year. Companies manufacturing automobiles, radios, refrigerators, and other household appliances normally introduce new models each year. Thus their business life is broken down into definite annual units in each of which a different product is produced and sold. An annual budget is logical in industries of this sort. Companies manufacturing shoes, clothing, and other products for which new styles are developed each spring and fall season, find a **six month budget period** most logical. A longer forecast of any accuracy is impossible because of the lack of information on styling of the product to be sold during the next succeeding period. Also, in such cases a shorter budget period does not give a complete picture of the cycle from production to sale to collection of receivables or include the **financing period** extending from the date of borrowing to the date of repayment.

**Annual Budget**—For concerns which do not have style seasons or model years, but do have a highly seasonal pattern of sales the annual budget is the most logical. In the **ice cream** industry, statistics gathered over a number of years show that the industry has a very definite seasonal sales pattern. For the industry as a whole approximately 45% of the annual production and sales occur in the summer months of June, July, and August, when plants operate at full capacity. Major repairs

replacements and installation of additional capacity take place in slack periods. In addition relatively heavy fixed charges involved in maintaining plant capacity to meet peak requirements and in continuing a competent organization, persist during months of low activity at relatively the same level as during the busy period. As a result the peak months show income and cash receipts above costs and cash payments while slack months call for expenditures and disbursements in excess of income and receipts. This means that the actual results of budgeted plans for any one month are difficult to appraise until the figures for all months are brought together to present a picture of the year as a whole. Like many other industries the seasonal nature of the ice cream business makes the annual budget the best basis for forward planning.

**Special Term Budgets**—Where the business is not highly seasonal does not introduce new models annually or have style seasons, the following three arrangements are possible:

- 1 Budgets may be prepared for a fixed period of three months, six months or a year as previously described.
- 2 Budgets may be kept always a certain period in advance of the current month by adding a new month to the forecast as each month is completed.
- 3 A combination of a summary long term budget and a more detailed short term budget may be worked out to provide a long term plan plus detailed coordination and control over a shorter term.

Closely related to the length of the budget period is the matter of subdividing the budget into shorter periods for greater detail in planning, finer coordination of activities, and more frequent comparisons of actual with budgeted results for control purposes. The budget for the entire period gives an over-all picture of expected results, analysis by shorter units of time makes possible a determination of each period's contribution to that objective through a comparison with the shorter period's budget. In a seasonal business it is possible that the actual results, taken by themselves may give a most unfavorable picture, but when viewed in the light of budget expectations for the period the results may be satisfactory. Many problems of coordination and control are time problems involving an answer to the question, "When?" A short period budget provides the basis for detailed coordination of production and sales and close forecasting of cash receipts and disbursements that would otherwise be impossible.

In most cases, the budget is subdivided by months, although for some activities a weekly or even daily forecast may be prepared. Ordinarily, it is not possible in budgeting to plan in advance all day-to-day and week-to-week details of operations, these are better treated as matters of continuous operating control. But operations can be planned accurately on a monthly basis and the budget for the month can be made to serve as a guide for the day-to-day decisions. Accordingly, analysis on a monthly basis is most common. This, of course, does not preclude division of the month into weeks or days for report purposes where it is desired to determine a portion of the month's budget accomplished to date.

**Beginning and Ending Dates**—Of equal importance with the length of the budget period are the beginning and ending dates. Activities to

be coordinated may occur in different months and if the budget is so placed in time that they fall in different budget periods, one important benefit of the budget has been lost. In some industries production occurs in the fall and early winter in preparation for the spring selling season. A budget period ending December 31 results in production plans being in a different budget period than the sales with which they should be coordinated. Where short term borrowing from a bank is resorted to, both the date of borrowing and the date of repayment should be covered by a single budget period. Every business has a fairly definite cycle, usually covering one year, and the use of this natural business year for both budgeting and accounting aids in making both accounting reports and budgets of greater value to management.

**PLACE OF FLEXIBLE BUDGET**—Forecast budgets have definite limitations for control purposes. If each manufacturing department operates at exactly the rate of activity planned, the forecast expenses provide a good basis for control, but this occurs seldom. Little real control can be obtained by comparing actual expenses for one rate of activity with budgeted expenses at another rate. Some expenses vary directly with volume and others do not. Real control is only possible when actual costs are compared with predetermined indications of what the expenses should have been at the attained volume.

This shortcoming of a forecast budget for control purposes has been overcome by the development of supplementary flexible or variable budgets, used primarily for control of manufacturing expenses. By a study of the classification of each expense as fixed, variable, or semi-variable, it is possible to develop a budget for each department in the plant. Such a budget can be utilized after the actual volume of operations for a period is known to determine the allowable expenses for that actual volume. Budgets of this type have been used most extensively and successfully for controlling manufacturing costs where the relation between volume and costs is most direct, but they have also been used to a limited extent in connection with the control of distribution and administrative expenses. This type of budget is considered in detail later in this Section.

**FREQUENCY OF REVISION**—As an aid in planning and a tool for coordinating the various activities the budget should be subject to frequent revision. If, as the year progresses, it becomes apparent that the sales forecast will not be met, it is obvious that production plans need to be scaled down. This may be done either within or without the budget structure. Before the advent of flexible budgets revision was considered undesirable because frequent changes reduced the usefulness of the budget figures for control purposes. Where a flexible budget is used for control purposes this objection is removed, since with changing conditions the forecast budgets can be brought up to date without affecting the basis for control. Today, in most companies budgets are regularly reviewed and revised where conditions indicate that the plan as originally developed cannot be accomplished.

**BUDGET MANUAL**—A budgetary control program which has as one of its objectives the careful planning of all activities is not complete unless the procedure for the development of budgets is also closely

	SALES BUDGET	PRODUCTION BUDGET
A. SALES MANAGER	<ol style="list-style-type: none"> <li>1. Anticipated sales to budget period by grade and put-up to E on or before 1st day of the 3rd week preceding budget period.</li> <li>2. Receive approved Sales Budget from E.</li> <li>3. Receive revised Sales Budget from E on or before 15th day after close of period.</li> </ol>	
B. WORKS MANAGER	<ol style="list-style-type: none"> <li>1. Receive copy of sales estimate from E on or before 3rd day of 3rd week preceding budget period.</li> </ol>	<ol style="list-style-type: none"> <li>1. Transmit estimate of production to E on or before 3rd day of 2nd week preceding budget period.</li> <li>2. Receive approved Production Budget from E.</li> <li>3. Report of production to E on or before 15th working day after close of period.</li> <li>4. Receive revised Production Budget from E.</li> </ol>
C. GENERAL MANAGER		
D. BUDGET COMMITTEE	<ol style="list-style-type: none"> <li>1. Review and approve within 2 days after receipt from E—return to E.</li> <li>2. Receive comparison of estimated and actual sales from E—report any revisions in Sales Budget to E on or before 15th day after close of period.</li> </ol>	<ol style="list-style-type: none"> <li>1. Review and approve within 2 days after receipt from E—return to E.</li> <li>2. Receive comparison of estimated and actual production from E—report any revisions in Production Budget to E on or before 15th day after close of period.</li> </ol>
E. ASSISTANT TO THE GENERAL MANAGER	<ol style="list-style-type: none"> <li>1. Submit copy of anticipated sales to B within 2 days after receipt from A.</li> <li>2. Original estimate to D on or before the 1st day of 1st week preceding budget period.</li> <li>3. Receive approved Sales Budget from D and transmit to A.</li> <li>4. Comparison of estimated and actual sales together with recommendations to D on or before 10th day after close of period.</li> <li>5. Transmit revision in Sales Budget to A on or before 15th day after close of period.</li> </ol>	<ol style="list-style-type: none"> <li>1. Receive and transmit estimate of production to D on or before 1st day of 1st week preceding budget period.</li> <li>2. Receive approved Production Budget from D and transmit to B.</li> <li>3. Comparison of estimated and actual production to D on or before 10th day after close of period.</li> <li>4. Transmit revisions in Production Budget to B on or before 15th day after close of period.</li> </ol>
F. STATISTICAL DEPT	<ol style="list-style-type: none"> <li>1. Report of actual sales for the period to E on or before the 5th working day after close of period.</li> </ol>	
G. ACCOUNTING DEPT		
H. PURCHASING AGENT		

FIG 1a Chart of

PAY ROLL BUDGET	STORES PURCHASE BUDGET	MATERIAL BUDGET
1 Estimate of the Sales dept pay roll to E on or before 10th day preceding budget period. 2 Receive approved Pay roll Budget from E. 3 Receive revised Pay-roll Budget from E on or before 15th day after close of period.		
1 Estimate of the factory pay roll to E on or before 10th day preceding budget period. 2 Receive approved Pay roll Budget from E. 3 Receive revised Pay roll Budget from E on or before 15th day after close of period.	1 Estimate of stores purchases to F on or before 10th day preceding budget period. 2 Receive approved Stores Purchase Budget from E. 3 Receive revised Stores Purchase Budget from E on or before 15th day after close of period.	1 Estimate of material required to E on or before 10th day preceding budget period.
1 Estimated administrative pay roll to E on or before 10th day preceding budget period. 2 Receive approved Pay roll Budget from E. 3 Receive revised Pay-roll Budget from E on or before 15th day after close of period.		
1 Review and approve within 2 days after receipt from E—return to E. 2 Receive comparison of estimated and actual pay roll from E—report any revisions in Pay roll Budget to E on or before 15th day after close of period.	1 Review and approve within 2 days after receipt from E—return to E. 2 Receive comparison of estimated and actual stores purchases from E—report any revisions in Stores Purchase Budget to E on or before 15th day after close of period.	1 Review and approve within 2 days after receipt from E—return to E. 2 Receive comparison of estimated and actual material purchases from E—report any revisions in Material Budget to E on or before 15th day after close of period.
1 Receive and transmit estimated pay-roll to D on or before 1st day of 1st week preceding budget period. 2 Receive approved Pay roll Budget from D and transmit to A, B and C. 3 Comparison of estimated and actual pay roll to D on or before 10th day after close of period. 4 Transmit revision of Pay roll Budget to A, B, and C on or before 15th day after close of period.	1 Receive and transmit estimated stores purchases to D on or before 1st day of 1st week preceding budget period. 2 Receive approved Stores Purchase Budget from D and transmit to B. 3 Comparison of estimated and actual stores purchases to D on or before 10th day after close of period. 4 Transmit revision of Stores Purchase Budget to B on or before 15th day after close of period.	1 Receive and transmit estimated material requirements to H on or before 10th day preceding budget period. 2 Receive and transmit estimated material purchases to D on or before 1st day of 1st week preceding budget period. 3 Receive approved Materials Budget from D and transmit to E. 4 Comparison of estimated and actual material purchases to D on or before 10th day after close of period. 5 Transmit revision of Material Budget to H on or before 15th day after close of period.
1 Report of actual pay roll to E on or before 8th day after close of period.	1 Report of actual stores purchases to E on or before 8th day after close of period.	1 Report of actual material purchases to H on or before 8th day after close of period.
		1 Receive estimated material requirements from E—submit estimate of material purchases to E on or before last day of the 2nd week preceding budget period. 2 Receive approved Material Budget from E. 3 Receive revised Material Budget from E on or before 15th day after close of period.

## Budget Procedure



PLANT AND EQUIPMENT BUDGET	MISCELLANEOUS EXPENSE BUDGET	FINANCIAL BUDGET
1 Estimate of expenditures for equipment to C on or before 15th day preceding budget period. 2 Receive approved Plant and Equipment Budget from E. 3 Receive revised Plant and Equipment Budget from E on or before 15th day after close of period.	1 Estimate of miscellaneous expenses by departments to E on or before 10th day preceding budget period. 2 Receive approved Miscellaneous Expense Budget from E. 3 Receive revised Miscellaneous Expense Budget from E on or before 10th day after close of period.	
1 See SALES MANAGER. 2 See SALES MANAGER. 3 See SALES MANAGER.	1 See SALES MANAGER. 2 See SALES MANAGER. 3 See SALES MANAGER.	
1 Receive and approve estimate of expenditures for plant and equipment—return to E on or before 10th day preceding budget period. 2 Receive approved Plant and Equipment Budget from E. 3 Receive revised Plant and Equipment Budget from E on or before 10th day after close of period.	1 See SALES MANAGER. 2 See SALES MANAGER. 3 See SALES MANAGER.	1 Review and approve estimate of cash receipts and disbursements from E. 2 Receive Financial Budget.
1 Review and approve within 2 days after receipt from E—return to E. 2 Receive comparison of estimated and actual expenditures for plant and equipment from E—report any revisions in Plant and Equipment Budget to E on or before 10th day after close of period.	1 Review and approve within 2 days after receipt from E—return to E. 2 Receive comparison of estimated and actual miscellaneous expenses from E—report any revisions in Miscellaneous Expense Budget to E on or before 10th day after close of period.	1 Review and return within 2 days after receipt from E. 2 Receive comparison of estimated and actual cash receipts and disbursements—report any revisions in Financial Budget to E.
1 Receive approved estimate of expenditures for plant and equipment from C—transmit to D on or before 1st day of 1st week preceding budget period. 2 Receive approved Plant and Equipment Budget from D and transmit to A, B, and C. 3 Comparison of estimated and actual expenditures for plant and equipment to D on or before 10th day after close of period. 4 Transmit revision of Plant and Equipment Budget to A, B, and C on or before 10th day after close of period.	1 Receive and transmit estimated miscellaneous expenses to D on or before 1st day of 1st week preceding budget period. 2 Receive approved Miscellaneous Expense Budget from D and transmit to A, B, and C. 3 Comparison of estimated and actual miscellaneous expenses to D on or before 10th day after close of period. 4 Transmit revision of Miscellaneous Expense Budget to A, B, and C on or before 10th day after close of period.	1 Prepare estimate of cash receipts and disbursements—submit to C. 2 Submit estimate of cash receipts and disbursements approved by C to D on or before 1st day of 1st week preceding budget period. 3 Receive approved Financial Budget from D and transmit to C. 4 Comparison of estimated and actual receipts and disbursements to D on or before 10th day after close of period.
1 Report actual expenditures for plant and equipment to E on or before 5th day after close of period.	1 Report actual miscellaneous expenses to E on or before 5th day after close of period.	

FIG 1b (Continued)

planned Budgeting is a cooperative undertaking involving a large number of individuals. To coordinate these individual efforts it is important that the procedure for budgeting be reduced to writing in the form of a budget manual. MacDonald (Practical Budget Procedure) has summarized the benefits of such a manual as follows:

The use of a budget manual furnishes an extremely helpful guide in both introduction and maintenance of a budget program. Authority and responsibility for the preparation and administration of the budget are clearly stated. The manual defines the duty and authority of each individual and committee as members of the budget organization and is a place of reference on budget procedure. It insures the preparation of each budget in a uniform manner. It assists the organization in coordinating its plans and activities. Finally a budget manual sells the advantages of budgetary control to the organization as a whole, particularly to those executives who are personally responsible for budget preparation and execution.

**Contents of Budget Manual**—While each budget manual is developed to meet the particular needs of the company for which it is prepared, some matters included in almost any manual are:

- 1 Objectives of the budget plan
- 2 Organization through which it functions
- 3 Duties and responsibilities of the budget committee, budget director, department heads and others responsible for the preparation and administration of budgets
- 4 Length of the budget period
- 5 Procedure for the approval and revision of budgets
- 6 Due dates for budget estimates and reports
- 7 Procedure for enforcing the budget

McKinsey (Budgetary Control) presents a complete manual on budgeting procedure. This manual covers the budget program as follows:

- 1 Statement of the function of each executive with reference to budgeting
- 2 Steps in the preparation of the sales budget when submitted reviewed and approved by the budget committee and general manager and the nature of the reports and revision of the sales budget
- 3 Handling of the production budget
- 4 Steps in building up the labor, materials, and expense budgets and the outline of the reports used to follow up these budgets
- 5 Development of the plant and equipment budget
- 6 Procedure for the control of departmental expense and the development of departmental expense budgets
- 7 Development of the financial budget
- 8 Preparation of preliminary estimated financial statements

In the case of each of these items very complete and definite statements are made so that the manual is in reality a useful guide in preparing the budget. This manual has been diagrammed and is reproduced here as Fig. 1. It should not be expected that the diagram can be used by every business. It is reproduced to show the coordinated and interrelated work necessary, and the need for a definite program covering every aspect of budgeting procedure.

**FUNCTIONAL BUDGETS**—In budgeting, the ultimate objective of budget preparation is the development of a forecast balance sheet and a forecast profit and loss statement. But in the process of developing

these summary budgets each element entering into them needs to be forecasted and planned and individual departmental or functional budgets organized into a unified whole. While details may differ from one company to another, all industrial companies have the same basic functions and need to prepare at least the following budgets:

- 1 Supporting Forecasted Profit and Loss Statement
  - a Sales Budget
  - b Production Budget
  - c Purchasing Budget
  - d Labor Budget
  - e Budgets of Manufacturing Expenses
  - f Distribution Expense Budget
  - g Administrative Expense Budget
- 2 Supporting Forecasted Balance Sheet
  - a Cash and Financial Budget
  - b Budget of Capital Expenditures

### Sales Budget

**SALES FORECAST**—A forecast is a statement of what may be expected to happen in the light of past experience, present conditions and any changes in factors influential in the past. A forecast is distinguished from a guess by the extent to which carefully analyzed and interpreted information provides its basis. The information contained in a sales forecast is developed to provide the following detailed information:

- 1 Sales by product lines. Few companies produce and sell a single product. If the production of each product or product line is to be planned the forecasts must be according to products or product lines.
- 2 Sales in units rather than dollars. For production planning purposes and inventory control units are essential. Conversion into dollars can be made later for the forecasted profit and loss statement.
- 3 Sales by territories. Territorial sales forecasts are needed to control sales efforts and help to assure that general business conditions in each territory have been given proper consideration. Further analysis into salesmen's quotas is also desirable.
- 4 Sales by months.
- 5 Sales by customer classes. When the product is sold at different prices to wholesalers, retailers, chain stores, etc., forecasts of sales by customer classes is needed for the determination of expected income and cash receipts and for evaluating the profitability of sales to each customer group.

Each company has its peculiar problems in deciding the amount of detail necessary in developing a sales forecast. The above is indicative of details most often found. In developing this information, the sales forecaster makes use of three types of data:

- 1 Analysis of past sales
- 2 Sales plans and policies
- 3 General and special business conditions

**ANALYSIS OF PAST SALES EXPERIENCE**—Any activities which take place over a period of time may be analyzed to determine

details which are merged or hidden in the actual figures. Statisticians list four such movements or trends:

- 1 Secular or long time trend
- 2 Cyclical movements
- 3 Seasonal pattern
- 4 Random fluctuations

Wars, strikes, special sales campaigns, a change of date in the introduction of an annual model, and similar occurrences give rise to random or irregular fluctuations. Being irregular and unpredictable in occurrence there are no statistical methods available for their measurement. In analyzing the sales of a business over a period of years, the influence of these factors must be estimated and eliminated in order that the data may be more fruitfully studied with respect to other and more measurable influences.

In studying past sales, it is preferable to state the figures in terms of units rather than value. Where only sales dollar statistics are available it is sometimes possible to develop price indices for several years and use these for reducing sales dollar figures to units of volume. In addition, analysis should be made separately for each major line of product. For a company making phonographs and radios an overall analysis has little value in indicating the growth or decline of radio sales as compared with phonograph sales. Likewise, a company manufacturing sporting goods must calculate separately the seasonal pattern for winter sporting goods, such as skis, skates, etc., and for summer sporting goods such as fishing tackle and baseball equipment.

**LONG TIME TREND**—Due to the growth or decline of population, improvements in the arts, changes in customer preference and numerous other factors the market for any product is likely to change over a period of time. The tendency to growth or decline is present in each individual business and in the industry of which that business is a part. The first step in analysis of a company's past sales experience is the determination and elimination of this long-time trend. Where sales for the industry as a whole are available, it is desirable to apply this analysis to industry sales as well as to company sales. This makes possible a calculation of per cent of industry sales enjoyed by the company each year and a calculation of any tendency for the company's proportion to increase or decrease. In the analysis of sales statistics for prior years it is advisable to plot them on a chart with the horizontal axis showing the years being studied and the vertical axis sales in units. It is sometimes helpful in visualizing the sales trend to connect the plotted data so that an irregular line represents the ups and downs of sales volume (Figs 3, 4, 7).

Various methods are used to determine the long-time trend and record it on the chart as shown in these three illustrations. In many cases a straight line may be drawn by inspection in such a manner that about as much area shows above the line as below. Other methods commonly used involve moving averages, use of semi-averages, and the method of least squares. Fig 2 illustrates the application of each of these three methods, and forms the basis for the chart in Fig 3.

(1)	(2)	(3)	(4)	(5)	(6)		(7)	(8)
Year	Sales (000 omitted) <i>y</i>	Three Year Moving Average	Semi- Average		Method of Least Squares		<i>xy</i>	Trend Ordinate
					Deviation from Mid Year <i>x</i>	<i>x</i> <sup>2</sup>		
1923	3 675	4 546		-7	49		- 32 410	5 577
1924	4 630	5 473		-6	36		- 32 004	6 444
1925	5 334	6 665		-5	25		- 32 275	7 811
1926	6 455							
Average Early Half			7 745					
1927	8 205	8 329		-4	16		- 32 820	8 178
1928	10 328	10 023		-3	9		- 30 984	9 045
1929	11 536	11 220		-2	4		- 23 072	9 912
1930	11 797	11 815		-1	1		- 11 797	10 779
Average of Series			11 148					
1931	12 111	11 759		0	0			11 646
1932	11 386	11 976		+1	1		+ 11 368	12 513
1933	12 450	12 668		+2	4		+ 24 900	13 380
1934	14 187	13 816		+3	9		+ 42 561	14 247
Average Late Half			14 551					
1935	14 810	15 288		+4	16		+ 59 240	15 114
1936	16 867	16 097		+5	25		+ 84 335	15 981
1937	16 615	17 160		+6	36		+ 99 690	16 848
1938	17 997			+7	49		+125 979	17 715
Totals	178 360				280		+242 711	
Omit 1923	-3 675							
Net	174 690							

Fig 2 Calculation of Secular Trend by Moving Averages Semi Averages and Method of Least Squares

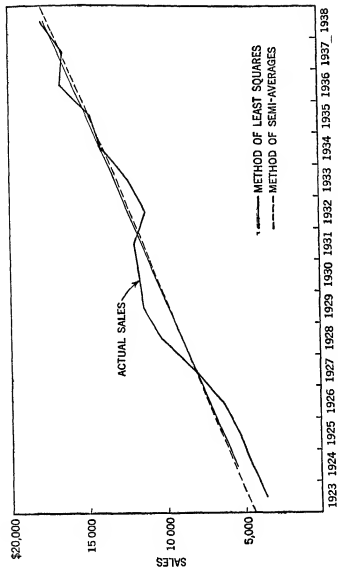


FIG 3 Actual Sales and Secular Trend

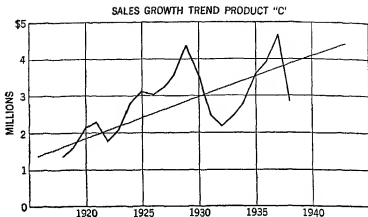


FIG 4 Sales Growth Trend

**Moving Averages**—In column 3 of Fig 2, the moving averages shown are obtained by adding together the sales for each three-year period beginning with the period whose center year is 1924. Thus sales for 1923-24-25 are added, and divided by 3 to arrive at 4,546 which is the moving average for the year 1924. While in the illustration a three year average has been used, it is possible that a five- or seven-year average or a four- or six-year centered average might provide a greater smoothing of the sales curve when plotted. In an actual case each should be tried to determine which most nearly produces a smoothed curve or a straight line. The object is to remove fluctuations due to other causes in order that the long-time trend may be revealed.

**Method of Semi Averages**—This method is based on the theory that a line which connects the average for the first half of the data with an average for the second half reflects the long-time trend. In Fig 2 the sales for the years 1923 to 1930 inclusive have been averaged to arrive at 7,745 which is placed between the years 1926 and 1927 (col 4). Sales for years 1931 to 1938 inclusive have been averaged and the result, 14,551 placed between years 1934 and 1935. Because the years used in this example represent an even number, the middle point in the series and in each half of it falls between two years, but in plotting this information this presents no difficulty. For example, if the trend figure of 1927 sales is wanted, add one-half of the annual increment to 7,745 and center the resulting figure in the year 1927. The difference between 14,551 and 7,745 is 6,806, representing eight years' growth or increment. Dividing by eight years gives an annual increment of 851. Half of this, or 425, added to 7,745 gives 8,170 as the trend figure for 1927. In the same way the figure for 1935 can be determined to be 14,976.

**Method of Least Squares**—The annual increase in sales is based on the following formula

$$\frac{\sum xy}{\sum x^2} = \text{Trend}$$

$x$  = Deviation of each period from middle year

$y$  = Sales of each period

$\Sigma$  = The sum of the respective values indicated

Substituting the values of Fig. 2 in the above expression,

$$\frac{+242,711}{+280} = 867$$

This represents the slope of the trend line, i.e., the annual increment in the trend ordinate, or the normal annual increase in sales to be expected. To obtain the average sales applicable to 1931 (the middle period) divide the sum of the sales (col. 2, Fig. 2) by the number of years, in this case, the year 1923 is omitted so that 1931 becomes the middle year in a series of 15 years:

$$\text{Average sales} = \frac{\$174,690}{15} = \$11,646$$

Deducting 867 from this figure gives the value for 1930 while adding 867 to 11,646 gives the value for 1932. In this way the computed sales for each year are determined.

An indication of the different results produced by the three methods is provided by noting the trend points for a few years, as follows:

Year	Actual Sales	Three Year Moving Average	Semi-Averages	Method of Least Squares
1927	8,205	8,329	8,170	8,178
1931	12,111	11,759	11,573	11,646
1935	14,810	15,288	14,976	15,114

An even better appraisal of the different results secured by the various methods is obtained by plotting the data (Fig. 3). The solid straight line is based on the method of least squares, and the line of dashes on the method of semi-averages. The moving average is not shown on this chart.

**CYCLICAL TREND**—Having measured the long time trend, the next step is to remove it from figures in order that the effect of the business cycle can be studied. This is usually done by determining the per cent by which each year's sales deviate from the trend line and plotting these deviations from a straight horizontal line taken as normal. The calculation is illustrated as follows:

Year	Sales	Trend Value	Deviation	
		Least Square Method	Amount	Per Cent
1931	12 111	11 646	+ 465	+4
1932	11 386	12 513	-1 127	-9
1933	12 450	13 380	- 930	-7
1934	14 187	14 247	- 60	- .5
1935	14 810	15 114	- 304	-2
1936	16 867	15 981	+ 886	+5
1937	16,015	16 848	- 233	-1
1938	17,997	17 715	+ 282	+1



Figs 5 and 8 illustrate the way in which deviations from the long time trend calculated as shown above can be compared with general business conditions. Zweckbionner (NACA Bulletin, vol 21) illustrates how past sales of a product are analyzed to determine the long term and cyclical trends. Fig 4 shows the actual sales curve after random fluctuations had been eliminated and also presents the line of long time trend. In Fig 5 sales for a part of this period have been expressed as a per cent deviation from normal and compared with an index of general business conditions.

**Lead and Lag and Deviations from Normal**—Two points should be noted in connection with Fig 5. First the dates of changes in the trend of general business are the same as the dates of changes in the trend of product C sales. In other words, there is no lead or lag apparent in these figures. In some cases it is found that sales of a commodity tend to move up or down either a certain length of time before the change

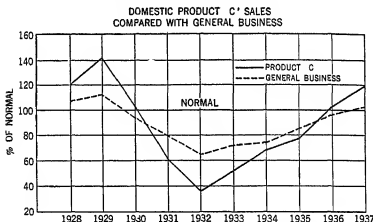


FIG 5 Product Sales Compared with General Business

in the trend of general business, or tend to lag behind general business changes by a definite period. Where the latter condition prevails, a valuable aid to forecasting is available. Naturally, this lead and lag condition is more likely to be apparent in monthly than in annual figures.

The second point of interest in Fig 5 is the amplitude of deviations from normal. While the general trend of product C sales is the same as the trend of general business, product C sales increase faster than general business when general business is above normal, and drop faster and farther than general business when business is below normal. This relation between the amplitudes of deviations can be measured and utilized to determine by what per cent over or under normal the sales of product C should be for any known deviation of the index of general business.

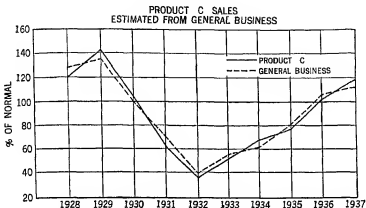


FIG 6 Estimating Product Sales from General Business Conditions

from normal. In Fig 6 the curve of general business has been multiplied by this factor and shows a close correspondence to sales of product C.

Figs 7 and 8 deal with an entire industry rather than a single company and illustrate a method of analyzing long time and cyclical trend in the sale of electric vacuum cleaners. They are explained by Schoenfeldt (N. A. C. A. Year Book, 1936) who states that a forecast of general business conditions constitutes the first step in setting sales budgets. The second step consists of relating the figures for a given industry to general business conditions. This is illustrated in Fig 7 in which the actual sales and the long time trend or growth factor for the industry are shown. These are expressed in units translated into dollars. In Fig 8 the long-time trend has been eliminated from the industry figures and the resulting residual fluctuations are compared with the general business curve. The sales are shown in units as per cent deviations from the trend line and then compared with an index of general business conditions.

**SEASONAL TREND**—Some industries are affected more than others by seasonal influences, but there are few which do not experience some effect from a change in the seasons. The usual method of stating the seasonal trend is to develop seasonal index figures for each month of the year. These seasonal indices state the per cent of each month's sales as compared with an average month. A simple method for arriving at seasonal indices is to express the sales for all Januarys for a period of years as percentages of the average monthly sales for the same years, and repeat the same calculation for each month. Assuming that sales figures are available for a ten-year period, proceed as follows:

- 1 Get the total sales for the entire ten years
- 2 Divide the above total by 120. This yields the average monthly sales
- 3 Get the total of the ten figures for January sales
- 4 Divide total January sales (item 3) by average monthly sales (item 2)

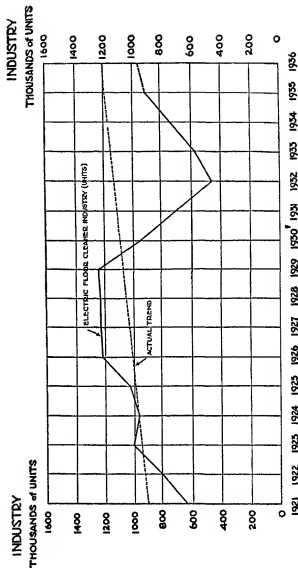


Fig 7 Actual Industry Sales and Trend (in units)

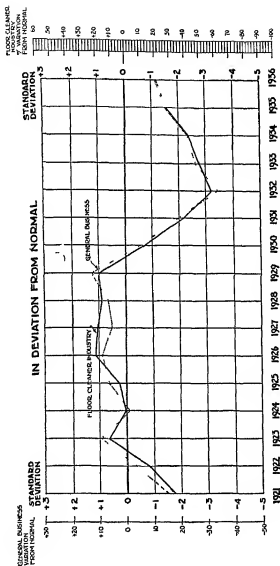


Fig 8 Industry Sales Compared with General Business

**Ratio to Moving Total**—One shortcoming of the above method is that the resulting figures still contain the influence of the long time trend. Januarys are influenced least by the trend of growth during the year, while December is influenced the most. One method of overcoming this difficulty is to relate the monthly figures to a period of time which has the individual month as its center instead of relating the monthly figures to the calendar year. This is called the "ratio to moving average" method. A modification of this method which might be called "ratio to moving total method" was described by Miller (N. A. C. A. Bulletin, vol 21). One difficulty of using a moving total to measure seasonal data is that a year is made up of twelve months, so that the middle point falls between two months instead of at the center of a single month. To overcome this difficulty, Miller combines two twelve-month periods, the second starting one month later than the first. For example, the data for the twelve months from January through December, with a center point between June and July, are combined with data for the twelve months from February through the following January, with a center point between July and August. By combining the two, the center point is shifted to the middle of July. While the total thus obtained is twice the annual total, this merely means that the ratios obtained by this method need to be multiplied by 24 in place of 12 in converting them to seasonal indices. Miller describes the operation of this method as follows:

Calculation of the necessary figures is shown in Fig 9. A mask similar to the one illustrated should be cut from the same ruled form and holes cut where the cross hatching is shown. When a properly cut mask is placed over the copied figures the values 851 and 768 will appear in the upper opening, and the figures 578 and 883 in the lower. The "write here" opening will be over 29,910 in the moving total column; however, this column should not be copied but computed to illustrate the method. While the mask is still in place a reference pencil line may be drawn under 851 and also under 578.

The actual adding operations may be performed on any direct subtraction adding machine or on any of the usual calculating machines. To obtain the first moving total (29,910) the figures between the pencil marks are added (768 through 578) and a subtotal taken. Then the subtotal is doubled and the two end January values (851 and 883) added once and the resulting subtotal recorded on the July line. The machine is not cleared and the mask is put back in place but with the "write here" opening one space below the July line on which the figure 29,910 has just been entered. The two subtractions and the two additions are made on the machine as indicated by the markings on the mask ( $29,910 - 851 - 768 + 883 + 1,043 = 30,217$ ). This new subtotal is recorded in the opening, and the mask moved down one more line. As the mask moves down the column two items are subtracted and two added at each step and a subtotal is obtained.

**Verification of Figures**—Since mistakes may occur in running the moving totals especially until the computer becomes quite familiar with the operation it is desirable to have a check on the work. Fortunately it is unnecessary to rerun the computations in order to have a check on accuracy. The check marks in Fig 9 at December, 1929 and December 1930 indicate proofs taken at those points. A check once a year proves all operations except the possibility that a figure may be miscopied from the machine dial or tape. It is desirable to fill in the check figures for once each year before actually running the moving totals with the mask. Then when the check figure appears in the "write here" opening in the mask and

agrees with the figure in the machine, the verified operation can be continued without even removing the mask

The sales figures are now divided by the moving totals and the resulting percentages entered in column 3 of Fig 9. When the divisions are completed, all of the ratios are grouped under the proper months (Fig 10)

### WORK SHEET FOR MOVING TOTALS

PERIOD	\$ SALES (000 omitted)	MOVING TOTAL	SALES - MOVING TOTAL
1929 Jan	851		
Feb	768		
Mar	1753		
Apr	2509		
May	2251		
June	1748		
July	1342	29910	4497
Aug	1095	30217	562
Sept	895	30751	291
Oct	686	31054	221
Nov	483	31140	158
Dec	578	31089	186
1930 Jan	883	30962	288
Feb	1043	30712	340
Mar	1992	30480	614
Apr	2563	30440	823
May	2293	30479	722
June	1658	30676	540
July	1308	30898	423
Aug	899	31011	283
Sept	899	31054	283
Oct	662	30907	214
Nov	546	30618	178
Dec	712	30505	233
1931 Jan	768	30338	319
Feb	1074	etc	
Mar	2004		
Apr	2394		
May	2163		
June	1672		
July	1124		
Aug	994		
Sept	etc		

### CUT OUT MASK

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FIG 9 Work Sheet for Seasonal Indices by Ratio to Moving Totals

## MONTHLY SALES AS PERCENTAGES OF THE MOVING TOTALS

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Totals
1929	—	—	—	—	—	—	4.49*	3.63	2.01	2.21*	1.9	1.60	
1930	2.85	3.40	6.04	8.39	7.02*	5.10	4.23*	2.3	2.3*	2.14	1.8*	2.03*	
1931	3.19*	3.55	6.59	7.37	7.12	5.39*	3.74	3.33*	3.06	2.67	1.98*	2.93*	
1932	3.98*	5.00	5.20	7.07	7.31*	5.30*	3.91*	3.70	3.04	2.57	1.92*	2.02	
1933	3.48	3.25*	5.3	7.84	8.09	5.44	3.97*	3.36	2.45	2.14	1.63	2.02	
1934	2.63	4.29	6.35	7.73*	7.27	5.43	3.71	3.05	2.50	2.44*	2.19	2.37*	
1935	2.84	3.26	5.80*	7.24*	7.08	5.74	4.37	3.12	2.33*	2.47	2.22	2.74	
1936	3.00*	2.72	6.24*	7.09	7.44*	6.16	4.37	3.39	2.67*	2.10	1.64	2.40	
1937	3.76	3.17	5.72*	7.20	7.63*	5.90	4.13*	3.24*	2.69*	2.77*	2.25	2.41	
1938	3.32*	3.00*	6.07*	7.45*	7.28	5.66*	3.80	3.19	2.34	2.25*	1.95*	2.50	
1939	3.61	3.39*	5.09	7.26*	5.17	5.32*	—	—	—	—	—	—	
Average of Values marked *	3.21	3.39	5.96	7.43	7.49	5.55	4.06	3.26	2.75	2.30	1.90	2.33	49.63
Averages X 24	77.04	81.36	143.04	173.32	179.76	133.20	97.44	78.24	66.00	55.20	45.60	55.92	1,191.12
Seasonal Index	78.	82	144	180	151	134	98	79	66	56	45	56	1,200

## ESTIMATED SALES FOR 1940

1940	937	956	1,731	2,163	2,175	1,610	1,173	949	793	673	553	673	14,474**
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Fig 10 Sales Forecast Based on Seasonal Indices

\*\* 105% of 1939

Examination of Fig. 10 makes it obvious that June sales in relation to the moving total fall between 5.40 and 6.16% while July sales fall between 3.71 and 4.49%. Thus we now have a measure of approximately how much the July sales typically fall below June sales.

**Median for Obtaining Monthly Sales Estimates**—To arrive at average of values for each month, what is called a "broad median" is used. The three highest values and the three lowest values are eliminated and an arithmetic average calculated for the four central values remaining. On Fig. 10 their central values are indicated by asterisks.

In Fig. 10 the average of the four values marked with asterisks for the month of January is 3.21% which is the seasonal value for that month. An adjustment to put the index in terms of a 100% base however makes it more convenient to use. Thus each month's average is multiplied by 24 since the moving totals were each 24 times as large as the average item. These values for each of the twelve months are totaled and in the illustration added to 1,191.12. For the months to average 100% the annual total must of course be 1,200 so we adjust by multiplying each month's value by the fraction 1,200 over 1,191.12. Now we have January rated at 78% of an average month while May is 181% of an average month, where all months average 100%.

To determine the seasonal distribution of sales for 1940 it is only necessary to multiply the individual monthly percentages by the sales forecast for the 1940 year after dividing the 1940 total by 12. This computation is shown on the last line of Fig. 10.

### ELIMINATING LONG TIME AND SEASONAL TRENDS—

For an analysis of the effect of general business conditions on sales, the monthly data are more useful than annual data. In using monthly sales data the influence of both long time trend and seasonal trend must be eliminated before the cyclical influence can be studied. This is readily done where these trends have previously been measured, by using the method illustrated in the following tabulation.

(1)	(2)	(3)	(4)	(5)	(6)
Period	Sales (000 omitted)	Trend	Seasonal Index	Normal	Actual % of Normal
January	38	37	95	35.2	108.0
February	41	38	97	36.0	111.1
March	46	39	101	39.4	116.8
April	50	40	102	40.8	122.5
May	45	41	101	41.4	108.7
June	42	42	99	41.6	101.0
July	41	43	96	41.3	90.3
August	39	44	95	41.8	93.3
September	47	45	102	45.9	102.4
October	49	46	103	47.4	103.4
November	46	47	103	48.4	95.0
December	47	48	106	50.9	92.3

By multiplying trend value for each month by each month's seasonal index a normal is obtained for each month. Actual sales are then expressed as a per cent of normal, and can be plotted above and below a horizontal line representing normal for comparison with various indices of general business.



**Comparing Sales with Indices of Business Conditions**—Generally it is found that sales of a product or product line over a period of time, with seasonal and long-time trends eliminated, follow rather closely the ups and downs of general business conditions. The analyst then compares the sales curve for the product being studied with various published indices to endeavor to find an index which correlates most closely with the sales figures. In some cases a single index is used, in other cases a composite index, made by combining several published indices, may agree more nearly with the sales figures. In the "Forecast of General Business for 1941" prepared by LaRose and Ottman representing a manufacturer of optical equipment, there appears the following statement regarding the general application of their forecast of general business conditions to sales budgeting:

To obtain a true approximation of a company's probable sales increase or decrease due to changes in general business activity, the normal long term trend of sales, or secular trend value for the year in prospect must be adjusted by a factor which measures the influence of the business cycle upon the company's sales volume. This factor is the deviation or degree of variation of the company's sales over a period of years from normal expectancy as expressed by the computed long term trend of growth or decline. The comparison of a company's sales deviation with the deviation of the general business index from its normal (100) allows management to determine within reasonably accurate limits the probable effect of general business changes upon company sales operations.

**Special Business Indices**—In some cases, an index of business conditions in a particular field, such as construction or transportation may provide a better guide than a general business index or may be combined with a general business index to form a composite index for a particular product group. Thus Schoenfeldt (NACA Year Book 1938), in connection with forecasting the sales of wing materials, by an electrical supplies manufacturer uses a combined index of general business conditions and conditions in the building industry.

Once an index has been found which reflects the effect of general business conditions or a segment of general business conditions on the sales of a product or product line, future forecasts of business conditions can be stated in terms of the index selected. Use of such forecasts in budgeting sales volume requires adjustments for taking cue of

- 1 Any lead or lag which characterizes the relationship between the two series
- 2 Any variation in amplitude of deviations from the normal for the two series

The necessity for considering these factors has been stressed by LaRose and Ottman, cited above, as follows:

Companies whose sales indexes normally "lag" or follow movements in the business index by several months possess a useful forecasting tool for anticipating short term movements in company sales volume. Companies whose sales indexes normally "lead" or anticipate movements in the business index are to an even greater degree faced with the necessity of forecasting general business trends for appreciable periods in advance of productive operations and inventories are to be kept in close control.

As the sales of different types of products show varying degrees of relationship with the movements in general business, it is highly desirable to

segregate sales operations by product lines and subject each product group to the analysis previously outlined. For example when the business index is 10% above its normal (100) sales of certain products may be 5 10 15 or some other per cent greater than their respective normal trends conversely when business is down 10%, the same products may suffer proportional losses

### FORECASTING GENERAL BUSINESS CONDITIONS—

Probably the most difficult phase of sales budgeting is arriving at a forecast of general business conditions for the budget period. Analysis of past sales experience provides a good understanding of the effect of general business conditions on sales of individual products or product lines, but to be of value this information must be used in conjunction with a general business condition forecast. Realizing the risk in depending on the judgment of any one individual or group, business forecasters have usually resorted to the practice of collecting a number of forecasts by others and from a study of these have developed their own prognostications. Schoenfeldt (NACA Year Book, 1936) has provided the following description of procedure adopted by a large manufacturer of electrical supplies

In our forecast of general business we make use of every possible method. We endeavor to secure from the leading services which publish indices of current business a forecast and we request each of them to project its published general business curve through the budget period just ahead.

Experts in business forecasting vary in their opinions. They cannot all be 100% correct and they tend to hedge in making their forecasts. But the extension of the business curve by various authorities resolves the forecast to a tangible basis and provides an external check upon our own calculations.

Our associates in other divisions also submit their business forecasts to us. In the meanwhile we in the commercial research division make our own forecast. This is based upon barometers of general business such as machine tool orders, the long term movement of the investment securities market and other indications of the trend of general business.

We also use what we term 'deductive economic analysis' wherein judgment is brought into play to determine the relative effect of known facts and factors upon probable future trends. Such a procedure may appear academic but the composite opinion from a number of active minds has proved helpful in securing a most accurate determination of business trends.

### ANALYTICAL APPROACH TO SALES FORECASTING—

The limitation of the statistical method in arriving at a sales forecast is that it is mechanical, and hence this method ought to be supplemented by something more flexible. Greater flexibility may be obtained by the so called analytical method of forecasting. Forecasting is the application of judgment and analysis to known facts and conditions to obtain the best possible approximation of what will happen in the future. Formulas can be used in analyzing past happenings to approximate the trends over a period of time, but in every case the results should be subjected to a test of judgment to see that they represent logical conclusions. The problem has been summarized by Eastwood (Sales Control by Quantitative Methods) in stressing the influence of competing industries, complementary industries, and industries which are either feeder or customer industries.

The analytical approach to the problem of forecasting cyclical movements presents a combination of whatever it may find useful and at the same time it does not hesitate to employ any or all of the various devices suggested in the statistical approaches. Thus it is not to be confined to any particular basis of forecasting, since it regards any fixed system as dangerous. It recognizes that there are merits in every system of forecasting.

In forecasting the cyclical fluctuations in the sales of a particular company the analytical approach involves the study of what is frequently referred to as "the statistical position" of the company's sales. Competing industries, complementary industries and feeder customer industries provide a convenient three-fold division of the industries whose trend of growth and present cyclical position have an important bearing upon the prospect of sales for a specific business enterprise.

The sales forecaster who does not possess knowledge of the trend of growth and relative position of competing industries can hardly be familiar with his own industry. The person who would undertake to forecast the sale of silk could hardly afford to be ignorant of rayon. If steel were his product he would need to study copper, wood and even the plastics. The study of these competing products and services represents an important phase of the analytical approach to sales forecasting. An analysis of industries and facilities that are complementary to the sale of a product or service will often repay the forecaster with helpful information. The secular trend of sales perhaps more than the cyclical movement, will be conditioned by the growth and development of closely related products and services. Improved highways and automobiles, automobiles and camping equipment, cycle paths and bicycles, trailers, camps and auto trailers, swimming pools and swim suits, these represent a few random examples of complementary relationships.

The third category of industries whose growth and cyclical position are to be studied in the analytical approach to forecasting, is composed of those whose productive activities serve either as feeders or as consumers of the industry in question. Steel and glass in the manufacture of the automobile, livestock as a basis for the meat packing industry, grain as grain for the milling industry and steel cans and bottles as containers for the products of breweries, canneries and distilleries constitute a few of the common feeder customer relationships in industry. The forecaster cannot hope to appraise properly the prospect of sales for a particular company without first studying the position that the company or the industry occupies with respect to those industries whose activities are linked with its own in the chain of industrial fabrication and marketing.

**Market Analysis for Determination of Territorial Potentials**—Another type of current information of considerable value in forecasting sales is that dealing with the potentialities of each sales territory. Hedges (N. A. C. A. Bulletin, vol. 14) has outlined the importance of this type of information in the following statement:

The available market that exists for a product in the country as a whole, and in a given area, and the share of that market that the company enjoys, or should enjoy are important in the forecast. If the sales forecast is tied up to the past sales only, the company and its sales policy are effectively anchored to the past.

Analysis of the potential market, the possibilities of exploiting these markets, and the incorporation of this factor as a definite part of the sales budget, represents the dynamic element in forecasting. It is the only element that yields a definite plan of lifting the company's sales out of the rut of the past, and of directing the sales program effectively toward sales progress.

The potential market for a specific product in a particular territory depends on a number of factors, among the most important of which are

- 1 Population
- 2 Need or desire for the product
- 3 Means of satisfying the need or desire

An illustration of the methods used by an electrical manufacturer in developing territorial potentials for radio sets is provided by Schoenfeldt (The Sales Budget, Its Organization and Control, Executive Service Bulletin, Metropolitan Life Insurance Co.) Three factors are combined, each of which has a definite influence in measuring the above potentials

- 1 Residential connected customers (wired homes) Ability to use electric sets
- 2 Income tax returns Ability to buy
- 3 Retail trade Willingness to buy

These individual factors, in the form of a percentage of the United States were added together, with equal 100% weighting for each of the first two and 75% weighting for retail sales because food sales emphasized the small towns too heavily. To some extent the use of retail sales in the index avoided a common difficulty. We had an index which partly measured the volume sold to retail stores and was not fully a consumers' index. This tended to recognize and allow for the drawing power of the larger communities.

Eveleigh (N A C A Year Book, 1930) gives the factors and the relative weights used in the experience of his company in marketing drugs and pharmaceuticals in Illinois. These items are shown below

1	Population	62%
2	Urban population	91
3	Drug stores	68
4	Physicians	73
5	Hospital beds	75
6	Income tax returns	91
7	Bank deposits	67
8	Motor registrations	60
9	Drug usage	52
10	Expenditure for medical attention	61

The percentages in the above table refer to the position of the State of Illinois in relation to the total for the entire United States. Sinclair (Budgeting) cites the case of a manufacturer producing a semi-luxury who estimates his market by constructing a territorial index based on the following data

- 1 The number of persons reporting annual incomes over \$1 000
- 2 The average income of each territory
- 3 The number of passenger automobile registrations
- 4 The percentage of dwellings equipped with electric lights and telephones
- 5 Expenditures for luxuries, based upon excise taxes
- 6 The circulation of certain magazines
- 7 The expenditures for education and school attendance
- 8 The percentages of foreign born and rural population

Studies of this type yield composite indices of purchasing power. As stated by Sinclair

Where this method is carried through the end result of the statistical work in relation to a product nationally distributed is to set a dollar valuation for possible sales for every county of every state in the United States. When this is done, a basis for establishing sales territories and of attaining a so called even representation is established.

The statistical analyses or indicators so developed for use in determining the sales quantity prediction should be subjected to correction for secular trend or natural change of business, business cycle changes, and lag or lead.

**Limitations of Analytical Approach**—The chief disadvantage of the analytical approach to forecasting lies in the difficulty of its application. There is no specific formula, since the procedure is not a mechanical one. To apply the method successfully, threefold knowledge is required:

1. Specific information with respect to the industry
2. A good grasp of statistical tools
3. Familiarity with general economic principles and the industrial system which these principles seek to explain

**ESTIMATES FROM FIELD**—Like the analytical approach, estimates from the field constitute another valuable adjunct to the statistical forecast of sales. This forecast is obtained by summarizing estimates prepared by the field sales force. The man in the field is constantly in touch with the trend of business in his territory and informed of the quantity of product in the customers' storerooms and on customers' shelves. Where data are available on the relation between past estimates and actual sales by individual salesmen, the individual estimates may be modified at the home office in the light of this past experience to give a valuable indication of the probable sales by territories and salesmen. Concerning the role and importance of the salesman in the preparation of a sales forecast, Sinclair (Budgeting) says:

Representative practice of American business and industry seems to place the responsibility for originating the sales estimates first with the salesmen or branch managers, and second with the sales management at the home office.

Statistical evidence on the origin of the sales forecast is furnished by the National Industrial Conference Board (Budgeting Control in Manufacturing Industry) as follows:

Origin	Number of Companies
Salesmen	31
Managers of branches, divisions, districts etc.	25
Sales managers including general sales managers	35
Sales committee	1
Special committee	2
Statistics department	2
Sales research department	1
Estimate department	1
Accounting and sales departments	2
Accounting and statistical departments	1
Some with salesmen, others with branch managers	1
	<hr/> 102

Estimates of salesmen may be obtained in two ways, through reports or by the conference method. One rubber manufacturer uses the report method in securing estimates based on product lines for each of his

thirteen major lines or markets Kohl (N A C A Bulletin, vol 21) describes how this method of field estimating provides for wide participation of the entire sales force in the preparation of a sales forecast for lines as follows

The general sales manager of this particular division is asked to give the budget department his estimated sales volume. The sales manager has under him in this case six zone managers. He asks each of these six zone managers for a sales estimate of his respective zone. Each of these six zone managers has under him eight or ten district managers who are asked by the zone manager to turn in a sales estimate.

Each district manager, in turn, has in his district from 50 to 100 dealers or customers. Now we are getting down to the fellow who has to do the work! The district salesman has before him a record of each of his dealers or customers showing him what each dealer bought by months in past years. From this record tempered by his ideas of what he thinks he can accomplish next year the district manager sets down the figures showing the orders he expects to get during the coming year. Here is where the budget really starts. These sales estimates must be shown, so far as possible, not only in total dollars but in dollars by products as well.

Then the estimates travel back to the budget department by the same route as the request followed, and at each stopping point along the way they are scrutinized and challenged for reasonableness. This must be done by those who, from experience, knowledge of general business conditions, and other factors, can temper and balance excessive optimism or pessimism of salesmen.

If the sales budgets of all district managers were set at the average, about half of them would have an easy time reaching their goal and would not put forth their maximum effort. Sales budgets while they should be reasonable should not be a "cinch." This, then actually comes down to two sales budget figures, a field budget and an actual budget based on expected average performance of all men combined. This is an example of what I mean by "reasonableness."

**SALES PLANNING AND SALES FORECASTING**—In forecasting sales, the net effect of all changes must be evaluated. These include changes in product, customers, territories, channels of distribution, price lists, and sales promotion. It is difficult to draw a clear line of demarcation between sales planning and sales forecasting. Both are the responsibility of the sales manager, and each decision which he makes with respect to sales policies and methods is accompanied by a forecast of the effect of that decision on sales volume and net profits. While the sales department is best able to judge the effect of the new policies and methods on sales volume, the budget director and controller are better qualified to interpret their effect on costs and final net profits. Accordingly, all important changes in sales plans must be reported to the budget director and the budget committee. The final decision on the probable effect of policy changes rests with the budget committee.

### Production Budget

**CONTENT OF PRODUCTION BUDGET**—The production budget can be divided into two parts, the first is a volume budget, the second a cost of production budget. The budgeting of production volume is primarily a matter of planning when goods whose sale is

forecast are to be produced. Such a budget provides a basis for subsidiary budgets of material requirements, labor requirements, and production capacity studies. The cost of production budget, on the other hand, provides a link with the forecasted profit and loss statement, and also with the cash budget.

**PURPOSE OF PRODUCTION BUDGET**—The purpose to be served by a production budget is to make provision for the following:

1. Production planning by answering such questions as
  - a. What shall be produced
  - b. When it shall be produced
  - c. In what quantities it shall be produced
2. A review of the productive capacity for meeting the production planned and for planning any additions or betterments for inclusion in the plant and equipment budget
3. Scheduling labor requirements
4. Scheduling material requirements and a purchase program
5. Cost of production and cost of sales figures for the forecasted profit and loss statement and a means of checking the profitability of product lines
6. Calculation of cash requirements to meet manufacturing costs

The first four of these purposes are served by a volume of production budget, the last two by a cost of production budget.

**PRODUCTION BUDGET AND MANUFACTURING PROCESSES**—The extent to which it is possible fully to accomplish each of these purposes and the method for gaining each depends largely on the nature of the production process. Palmer (N. A. C. A. Bulletin vol. 7) has provided a picture of the way in which the problem varies with the type of production.

Our simplest case is the producer of a single stock product of few parts or ingredients. In a situation of this kind manufacturing processes are simple and are apt to be so automatic as to reduce labor to a position of comparative unimportance. Raw materials are few and are consumed in known proportions. The situation is an ideal one for detailed planning both of volume of output and of cost.

A second case is that of the producer of a single stock product of complex construction. The budgeting of production in this instance usually involves more detail than in the first case and is therefore more expensive.

In the case of an assembled product the various parts of which are manufactured and not purchased the budgeting of production for operating departments is much the same as though several or many individual products were being manufactured. It is simplified however by the fact that there are definite quantitative relationships between the various units or parts.

A third type of manufacturing enterprise is the business producing a large number of different products for stock. It will usually be found in this type of business that a relatively high percentage of the total volume of business is made up of a few products. In two different cases, for example, of plants producing over 15,000 products it was found that over 70% of the sales were on approximately 500 products. It is not difficult to schedule the production of 500 products, nor does the clerical procedure involved add much to manufacturing cost. A plant in Indianapolis by budgeting the production of certain products in a situation similar to that outlined above effected a net saving in cost of approximately 10%. Admitting without argument the folly of detailed schedules for all products in

certain situations it should be emphasized that there is a place for production budgets if savings can be effected by scheduling only a part of the total volume.

The most difficult situation which an executive is called upon to face in budgeting production is that found in a business producing a great variety of products entirely to special order. It is sometimes possible to consult the production plans of the customer and budget on a basis of the information thus secured. If through financial inducement or otherwise the customer can be persuaded to contract well in advance of delivery so much the better. Assuming however the worst possible case in which the accurate estimating of production requirements is impossible it frequently is true even here that raw material and labor requirements can be planned to good advantage and with reasonable success. Though the products of a concern are many the types of raw material and classes of labor needed in their production may be few. An iron foundry is a case in point.

**NATURAL BUSINESS YEAR**—In a company with seasonal sales which has adopted a natural business year, the peak of sales comes near the end of the fiscal period, making possible production of goods earlier in the year to meet the sales peak. Companies using an unnatural fiscal period with a sales peak early in the fiscal year get little help in production planning from their budgets, because the periods of production fall in a budget period preceding the period when goods are sold. A first step for such companies is a shift to their natural business year.

**ADVANTAGES OF PRODUCTION BUDGET**—According to Bernard (N. A. C. A. Bulletin, vol. 17) the advantages resulting from a properly operated production budget are

- 1 Inventories are maintained at a reasonably low level and unreasonable obsolescence and mark downs guarded against
- 2 Excessive inventory valuations, necessitating write down adjustments due to market price declines, are avoided
- 3 Low inventories increase turnover thereby retaining the assets in a more liquid state
- 4 With production schedules based on anticipated sales raw material requirements can be established beforehand thereby obtaining better prices and better deliveries
- 5 Production is concentrated on goods that should be on hand when required by the trade
- 6 Uniform production results in decreased costs and enhances the goodwill of employees and customers

**PLANNING PRODUCTION FOR STOCK**—Where production is wholly or largely for stock, the production budget can be more specific and give a more detailed analysis according to product lines than is the case in producing to customers' orders. Preparation of a volume of production budget in such a case involves a study and correlation of three types of information

- 1 A sales volume budget based on products or product lines (See discussion earlier in this Section)
- 2 A determination of the inventories of finished products desired at the end of each month or other selected period
- 3 A statement of the productive capacity in terms of departments or operations



Fig 11 shows a production estimate schedule illustrating how sales estimates are converted into production schedules. It is explained by Coonley (*Scientific Management in American Industry*)

Fig 11 shows how quarterly sales estimates are converted into quarterly production allotments that are in line with administrative standards relating to production sequence. The data on the schedule usually include estimates of orders for a full twelve months ahead and such lengthy estimates serve as background material for fixing the production rate even though the specific calculations in columns A to K relate to but a six month span. Several interested executives enter their respective estimates in columns A to K but the committee's authorization entered in column L is not a complete calculation inasmuch as it may be freely affected by judgment. We attempt always to gain constant adjustment to an averaged rate of production, often preferring to finance increased stocks prior to an expected peak of demand rather than to fire and rehire our trained workers.

In the process of arriving at a wise judgment on each class of product it is of inestimable value for the administrative staff to consider the "normal" standards that show upon the table. The budget order rate set for each group represents the normal or average level anticipated according to the original annual budget for the year. The budget stock level represents the "number of months' stock" that should be carried on hand on the average to give good service at the standard rate of orders. The normal rated capacity standard represents the maximum productive output that might be attained under normal conditions and without working overtime. Naturally, this can be exceeded for short periods but could not be exceeded continuously without possibility of developing excessive costs.

**Stabilized Inventories versus Stabilized Production**—In any business with seasonal sales there is always the problem of deciding whether to stabilize production and employment by producing in slack periods to meet later sales requirements. One of the primary gains which can be attributed to the increased use of a budgetary control method is the resulting greater stabilization of production and employment through advance planning. In the past, great emphasis has been placed on inventory turnover secured by keeping inventories at a minimum. To some extent this emphasis is now replaced and modified by a better understanding of the costs of labor turnover and overhead costs of idle and excessive productive capacity. The decision as to how far a company should go in attempting to equalize production and employment is largely a matter of balancing the costs of maintaining inventories against the costs of labor turnover and the cost of maintaining capacity which is used for only part of a year. Listed below are the more important of these considerations:

- 1 Considerations favoring minimum inventories, i.e. production in line with sales requirements
  - a Minimum investment in inventories
  - b Reduced interest cost where capital is borrowed
  - c Less insurance required on inventories
  - d Less storage space and handling required
  - e Small property taxes
  - f Less chance of spoilage and obsolescence
  - g Less risk of price decline and changes in customers' demands

PRODUCTION ESTIMATE SCHEDULE																		JAN 1-JULY 1 19--			
PRODUCT CLASS	ESTIMATES BY TONS	ORDERS				INVENTORY				PRODUCTION				FOR COMPARISON							
		EXCESS UNFILLED BY ORDERS	1st QUAR	2nd QUAR	COMB QUARS	PRE DICTED AMOUNT 1/1--	DESIRED 1/1--		AMT OF INV	CHANGE	1st & 2nd QUARS		COMMITTEE'S AUTHORIZED PRODUCTION		ORDERS				PREVIOUS PROD QUOTA	NORMAL STANDARDS	
							F	G			H	K	L	M	N	P	Q	R			
		A	B	C	D	E	F	G	H	K	L	M	N	P	Q	R					
					A+B+C			F-E	B+G	H-2											
X	PLANNING	0	435	480	915	400	375	-25	890	445		480	405	1800			BUDGET ORDER RATE -450				
	SALES	0	400	480	880	400	400	0	880	440	440				470		BUDGET STOCK LEVEL -400				
	PROD	0	375	450	825	400	375	-25	800	400							NORMAL RATED CAPACITY -500				
Y	PLANNING	0	375	360	735	255	300	+45	780	390		385	360	1480			BUDGET ORDER RATE -000				
	SALES	0	350	360	700	255	330	+75	775	388	390				410		BUDGET STOCK LEVEL -000				
	PROD	0	375	390	765	255	300	+45	810	405							NORMAL RATED CAPACITY -000				

Fig. 11 Quarterly Production Schedule Based on Sales Forecasts

- 2 Considerations favoring building of inventories in slack periods, i.e. stabilized production
  - a Less labor turnover with resulting better morale improved production and reduced costs of hiring and training
  - b Possible savings in social security taxes under merit rating provisions
  - c Possible elimination of added labor costs of overtime
  - d Less productive capacity required through leveling of production peak thus decreasing fixed charges and unabsorbed overhead
  - e More even utilization of staff and better trained staff possible
  - f Production in most economical size lots possible
  - g Most efficient equipment, labor and supervision can be utilized

The extent to which each of these considerations is of importance to the individual manufacturer depends upon the following factors:

- 1 Adequacy of funds for financing inventory accumulations
- 2 Whether the product is staple or subject to style changes and customers whims
- 3 Productive capacity available at the time the question arises
- 4 Proportion of skilled to unskilled labor and the local supply of each
- 5 Tendency toward wide fluctuations in the price of raw materials and finished goods
- 6 Relative importance of set up costs in relation to operating costs

**PRODUCTION VOLUME**—Sales executives are not always cognizant of the fact that the sales program may produce an unbalanced production schedule. The sales manager may emphasize volume and overlook balance, he may look to gross margins based on the unit costs of individual products and entirely overlook the unallocated costs in idle and only partially used equipment. In his desire for new products and then substitution for present products which the company has the equipment to produce he may cause purchase and installation of new capacity thus might render equipment already available, partially or wholly idle. Thus a study of productive capacity and its relation to the sales budget becomes a matter of considerable importance.

Such a study is also desirable as a means of locating bottlenecks. No plant can have a productive capacity in excess of that of the department or process which has the least capacity. Overall capacity in a plant is determined by the bottleneck department and the production of other departments limited by it. Where a sales budget calls for production in excess of the capacity of the bottleneck department, consideration must be given to securing additional capacity in order to provide a better balance with productive capacities of other departments. (For detailed discussion of plant capacities see Section 20.)

Where maintenance of minimum inventories is the agreed-upon policy, it is essential to have a proper balance of each type of product in the inventory at all times. Accordingly, a calculation of planned production is made for each product or line of products individually, and the results combined to give a total production forecast.

	January	February	March
Forecasted sales (in units)	80 000	120 000	150 000
Add desired inventory end of month	100 000	130 000	110 000
Total	180 000	250 000	260 000
Less inventory, beginning of month	70 000	100 000	130 000
Scheduled production	<u>110 000</u>	<u>150 000</u>	<u>130 000</u>

Where stabilized production is the objective sought, it is often desirable first to convert the sales forecast into productive hours required on a departmental basis. A comparison, department by department, of productive capacity required with productive capacity available, focuses the attention on bottleneck departments and on departments whose capacities are not adequately utilized during certain periods of the year. The problem then becomes one of deciding which products can be manufactured in advance of needs as a means of equalizing employment. The following considerations offer aid in making this decision:

- 1 Staple products are safer to stock than style goods or novelties
- 2 Since the object is greater utilization of labor in a period of slack sales, products having a high proportion of labor cost should be manufactured in advance in preference to products with a high proportion of material cost. Thus investment in inventory is minimized.
- 3 Select those products whose selling price is least subject to fluctuation. This minimizes risk of high inventory write downs.
- 4 Select those products made of raw materials whose price is least subject to fluctuation.
- 5 Where different products utilize different productive facilities or the same facilities in different ratios, plan shifts in production to bring about balanced utilization of facilities and make unnecessary the shifting of workmen from one department or operation to another.

Naturally, all these objectives cannot be realized in full, but a careful consideration of all of them helps to maximize the gain from stabilized production and minimize the loss from obsolescence and price declines and the expense of building up a larger than normal inventory.

**Correlating Sales and Productive Capacity**—An example of how a shoe company correlates production with sales forecasts and plans production in anticipation of the time when sales exceed productive capacity is provided by Wonson (NACA Bulletin, vol 16). In explanation of the production budget (Fig 12), Wonson points out:

Two factors control the number of pairs of shoes the factory must deliver each month to the "in stock" department, first the number of pairs of shoes we expect to ship from the stock department to customers and secondly the increase or decrease which must be made in this figure to adjust the stock on hand to the proper figure for the first of the following month.

Stock shoes are not built to the customer's specifications but are designed and constructed according to our idea of the styles and types which will be most in demand. In order to handle the customers' orders for immediate delivery we must have on hand on the first of each month a basic stock which we have learned from experience should amount to one and one half times the number of pairs we expect to sell during that month.

The shoe business is highly seasonal as the retailers call for a substantial part of their spring and summer shoes in the months of March and April and of their fall and winter shoes in the months of August and September. When we are approaching a month of heavy demand, we must therefore increase our basic stock as well as deliver sufficient shoes to cover the expected sales of the current month. When we are approaching a month of low demand, we decrease our basic stock by delivering to the stock department a smaller number of shoes than are required to fill the customers' orders during that month.

PRODUCTION BUDGET						
Stock Shoes—Required Deliveries to Stock Department						
January June 19—						
	Month	(1) Expected Shipments	(2) Required Stock 1st of Month	(3) Change in Stock Dur- ing Month	(4) Required Delivered During Month	
FACTORY A	Grade A	January	5 000	8 400	2 800	8 400
		February	7 500	11 200	5 300	12 800
		March	11 000	10 500	2 000	8 400
		April	9 500	13 000	2 700*	6 000
		May	7 500	11 500	2 000*	5 500
		June	6 100	9 500	0	6 100
	Grade B	January	8 000	12 800	4 200	12 700
		February	11 300	17 000	7 200	18 000
		March	10 100	24 200	8 000*	18 100
		April	14 100	21 200	4 200*	0 000
		May	11 300	17 000	3 200*	8 100
		June	9 200	13 800	0	9 200
FACTORY B	Grade C	January	14 000	21 800	7 400	23 000
		February	10 500	29 200	12 800	31 800
		March	27 000	41 500	5 000*	27 000
		April	24 300	36 500	7 300*	17 000
		May	19 500	20 200	5 800*	14 000
		June	15 900	23 700	0	15 800
	Grade D	January	0 700	14 000	4 000	14 000
		February	13 000	19 500	3 400	21 400
		March	18 000	27 800	3 000*	15 000
		April	16 200	24 300	4 500*	11 400
		May	13 000	19 500	3 700*	9 200
		June	10 500	15 800	0	10 500
* Red						
EXPLANATION						
Column 2 One and one half times column 1—stock in pairs required to cover fluctuations in orders from customers by styles widths and sizes						
Column 3 Additions to or subtractions from production required to meet shipments to correct basic stock on first of following month						
Column 4 Sum of columns 1 and 3						

FIG 12 Production Budget in Relation to Required Stock

The illustration below shows how this calculation is made to determine the production of Grade A shoes for Factory A for the month of January

Required stock first of February (equal to $1\frac{1}{2}$ times February sales)	11 200
Sales for January	5 600
Total	10 800
Required stock January 1	8 400
Required production for January	<u>8 400</u>

In addition to producing for stock, this company produces shoes to customers' orders. This necessitates a further adjustment in the production plan. Wonson describes the way in which this adjustment is made in the production budget for Factory B (Fig 13), as follows:

As the peak demand for stock shoes coincides with the peak demand for makeup deliveries production by the factory exactly in accordance with the requirements for delivery would impose a productive burden on the factory which it could not meet without expanding its floor space and equipment materially.

Fortunately we can control the production of stock shoes and Fig 13 shows our method of computing the quantity of stock shoes we must make in advance of the requirements for shipment in order to use our productive capacity to the best advantage. As November, December and January are months of comparatively low requirements for shipments we start to build up a surplus usually of staple shoes during these months to offset the shortage which is sure to develop in February and in March.

### PRODUCTION BUDGET, FACTORY B

Required Deliveries by Factories to Consumers and Stock Department  
January-June 19—

	Jan	Feb	Mar	Apr	May	June	Total
TABLE 1 OVER OR SHORT BY MONTHS							
Make Up Grade C	7 800	10 500	14 900	13 000	10 500	8 500	65 000
Make Up Grade D	5 200	7 000	9 900	8 700	7 000	5 700	43 500
Stock Grade C	22 000	31 800	22 000	17 000	14 000	15 800	123 200
Stock Grade D	14 000	21 400	15 000	11 400	9 200	10 500	82 200
Total	49 000	70 700	62 400	50 100	40 800	40 500	314 100
Shipping Days		9 <sup>2</sup>	19	21	21	22	16
Shipping Capacity	57 700	49 800	55 100	55 100	57 700	42 000	
Over or Short	8 100	20 900*	7 200*	OK	OK	OK	

#### TABLE 2 OVER OR SHORT BY STOCK GRADES

Grade C	4 900	12 500*	4 400*
Grade D	3 200	8 400*	2 900*

Surplus Produced in No

vember and December

Grade C 12 000

Grade D 8 100

Balance of February and March Shortage added to January Deliveries

#### TABLE 3 ADJUSTED BUDGET OF DELIVERIES

Make Up Grade C	7 800	10 500	14 900	13 000	10 500	8 500	65 200
Make Up Grade D	5 200	7 000	9 900	8 700	7 000	5 700	43 500
Stock Grade C	26 900	19 300	18 200	17 000	14 000	15 800	111 200
Stock Grade D	17 800	18 000	12 100	11 400	9 200	10 500	74 100
Total	57 700	49 800	55 100	50 100	40,800	40 500	294 000

Normal Month Delivery

Budget 40 000 49 000 49,000 49 000 49 000 40 000

Per Cent Estimate of Normal 118% 102% 113% 102% 83% 83%

\* Red

FIG 13 Correlating Production for Stock and for Customers' Orders

**Variable Inventory Turnover**—In a company with sales branches, consideration must also be given to the need for a minimum inventory of finished products at each branch. This requirement in the case of one company is met through a control chart (Fig 14) for finished goods

FINISHED GOODS INVENTORY CONTROL CHART

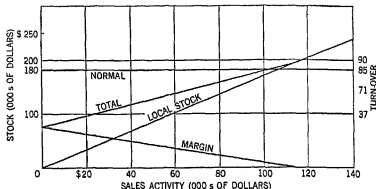


Fig 14 Finished Goods Inventory Control Chart

inventories developed for this company. This chart makes use of a variable turnover rate as a means of stabilizing production, and is described by Zweckbionner (N A C A Bulletin, vol 21)

It is interesting to note that in working out this chart we discovered upon interviewing the several executives charged with the responsibility of maintaining this inventory, that it was desirable to maintain certain stocks at several keypoints located throughout the country in order to service properly the stocks carried in each of the sales branches. This stock we labeled marginal stock, and we felt that it should be at a minimum when sales activity is 100% or more of normal. Therefore in considering that it is desirable to have inventory to act as a cushion for production this marginal stock should increase considerably as business drops off so that marginal stock reaches its highest point when sales activity has reached its lowest point. It was also felt that the inventory on hand in the various sales branches should increase and decrease directly in proportion to sales activity. These charts (there being one worked out for each classification of inventory) should serve as a guide for measuring our efforts to control inventories as well as provide the basis on which we plan our production for the forthcoming year.

The same source also presents the data shown in Fig 15 and the following comments in support of this method.

Let us compare what our inventories and production programs would have been during the past six year period using these principles as the basic policy with what the results would have been had we been blindly following the policy of maintaining a constant turnover ratio of one per year.

On Fig 15 appears the opening inventory at the beginning of 1933 and

**SALES, INVENTORIES AND PRODUCTION (in Units)**  
**Two Principles Compared**

This is what might happen to production requirements if management adhered to one turnover per year

Year	A	B		C	D
	Actual Sales	Inventory			Production
		Opening	Closing		
1933	80,000	80 000	80 000		80,000
1934	96 000	80 000	108 000		124 000
1935	107 000	108 000	106 000		106 000
1936	150 000	106 000	194,000		238 000
1937	176 000	194 000	158,000		140 000
1938	127 000	158 000	96 000		96,000

This is what would happen to production requirement if management were following the variable ratio of inventory turnover as outlined on the chart

1933	80,000	80 000	143 000	143 000
1934	96 000	143 000	150 000	103 000
1935	107 000	150,000	180 000	137 000
1936	150 000	180 000	187 000	167 000
1937	176 000	187 000	163 000	152 000
1938	127 000	163 000	180,000	144,000
1939	152 000			

$$A - B + C = D$$

**FIG 15 Production Requirements under Fixed and Variable Inventory Turnover Ratios**

in the first column appear the sales figures for each of the six years under review. With this information we are able to estimate what production would have been in each one of the years in order to provide an inventory turnover rate of one per year in consideration of the sales volume turned over. It will be noted that production ranges from 238 000 units which was the high year, to 80,000 units which was the low year. However had the policy been in effect, as was demonstrated on the charts employing the variable turnover ratio principle we would see a reduction in the range of estimated production units for in the high year production is estimated at 167,000 and in the low year it is 103 000. This is evidence of the effect of the principle in flattening out the production curve.

**WORK IN PROCESS INVENTORIES**—The production budget must be modified to give consideration to changes in the volume of work in process at the end of each month. Where the policy is to keep the finished goods inventory at a minimum and related to sales demand an increase in sales must be anticipated by increasing the work in process. The average length of the production cycle indicates how far in advance of an increase in sales the increase in production must be planned. Similarly, a reduction of work in process must precede a forecasted drop in sales. It should be noted that production must be accelerated faster than sales on the upturn, and decelerated faster than the



	Direct Labor	Material	Overhead			Grand Total	Net Sales
			Fixed	Variable	Total		
Net Sales actual. Cost of Sales actual	\$561 800	\$668 600	\$336 000	\$494 400	\$830 400	\$2 060 800	\$3 070 000
Deduct Excess Direct Labor (roughly 6%) Unabsorbed Overhead (roughly 4%)	31 800			19 000	19 000	31 800 19 000	
Cost of Sales at standard-actual (Direct labor and material are at actual cost overhead is at standard cost)	\$529 800	\$668 600	\$336 000	\$475 400	\$811 400	\$2 009 800	
Adjustment of year's operations to basis in effect on January 1							
Net Sales Sales prices were advanced 5% on May 1 which basis is still in effect on January 1. Sales prior to the advance amounted to \$1 000 000. Therefore 5% of \$1 000 000							\$0 000
Materials The material cost in December 31 inventory which is also the market cost is 5% in excess of the material cost in the year's cost of sales. Therefore 5% of \$668 600		33 400				33 400	
Year's operations as adjusted at standard cost to basis in effect January 1	\$529 800	\$702 000	\$336 000	\$475 400	\$811 400	\$2 043 200	\$3 120 000
% of cost elements to net sales	16.98%	22.50%	10.77%	15.24%	20.01%	65.40%	
% of cost elements to net direct labor	100.00%	133.90%	63.43%	89.73%	153.16%	285.65%	

Fig 16 Adjustment of Actual Costs to Predetermine Cost Percentages

decline in sales on the down grade, if the policy of keeping inventories in direct relation to sales is followed. This is true because an increase in sales requires added production both to meet the increased sales and also to keep the inventory in the desired relation to sales. This is one of the undesirable features of attempting to maintain a fixed rate of inventory turnover for all rates of sales activity.

**COST OF SALES BUDGET**—The method followed in the preparation of a cost of sales budget depends largely on the type of cost system in use. The ideal situation is found where a complete system of standard costs is in use. This means that standard cost cards are available for each product manufactured, making possible a determination of the standard cost of forecasted sales by simply costing each product in the sales budget at the standard and summarizing. Since in some standard cost systems the inventories as well as the cost of sales are stated at standard the primary problem is forecasting the volume and other variances from the predetermined standards by months.

Where an actual cost system is used, it is possible to forecast the cost of goods sold by the use of percentages based on past experience adjusted for known difference between the past period and the budget period. Fig 16 is an illustration of how the results of a prior year can be used to determine the percentage of various cost elements to sales and direct labor costs. This illustration was presented by Bernard (NACA Bulletin, vol 17) in describing the methods used by one manufacturer in preparing the monthly production forecasts. Note that materials and labor are based on actual cost, whereas overhead is based on standard cost.

We now have the basis for determining our cost of production at standard and by adjusting the standard for excess direct labor and material price variation and over and underabsorbed overhead the total production cost is obtained. The factory production forecast is developed from the above basis as follows:

	January	February	March
Net Sales	<u>\$260 000</u>	<u>\$250 000</u>	<u>\$275 000</u>
Basic Cost of Sales			
Direct Labor net (16.98% of sales)*	\$ 44,148	\$ 42,450	\$ 46 695
Material (22.50% of sales)*	58,500	56 250	61 875
Overhead			
Fixed (Schedule 1)	28 000	27,600	28 000
Variable (15.24% of sales)*	39 624	38 100	41 910
Total	<u>\$170 272</u>	<u>\$164 400</u>	<u>\$178 480</u>
Add			
Excess direct labor (6% of net direct labor)*	2,652	2,550	2 805
Unabsorbed overhead (4% of variable overhead)*	1 576	1 500	1 690
Estimated Production Cost	<u><u>\$174 500</u></u>	<u><u>\$168 450</u></u>	<u><u>\$182 975</u></u>

\* See Fig 16

## FIXED CHARGES

	Estimate for First Quarter			Schedule 1
	January	February	March	
Indirect Factory Labor				
Executives (\$2,000 per month)	\$ 2 000	\$ 2 000	\$ 2 000	
Foremen (\$1,000 per week)	4 400	4 000	4 400	
Taxes	5,000	5,000	5 000	
Insurance	500	500	500	
Light Heat and Power	7 500	7 500	7 500	
Depreciation	8 600	8 600	8 600	
	<u>\$28 000</u>	<u>\$27 600</u>	<u>\$28 000</u>	

## Material and Labor Budgets

**PLANNED MATERIAL PURCHASING**—Responsibility for development of a purchase budget rests with the purchasing department, though the latter is necessarily governed by company policy with respect to inventories of materials and supplies. The time of purchase of the required material involves a consideration of company policy with respect to the size of raw materials inventories, economical purchase lots, financial condition of company, condition of the market and similar factors. The purchasing department is best qualified to combine these various considerations and to develop a program of planned purchasing based on material requirements. There are four methods in general use today for controlling additions to raw material inventories. These are

- 1 Detailed budgetary control
- 2 Control through maximum stock limits
- 3 Speculative purchasing
- 4 Purchasing to specific customer orders

Most companies use a combination of two or more of these methods. The basic raw materials may be purchased in line with a detailed purchase budget based on a production budget, while secondary materials and supplies are purchased on the basis of purchase requisitions issued by a stock clerk when any item reaches the minimum set by the stock records. In those industries where the basic raw material is subject to great price fluctuations speculative purchasing may be the practiced, although not always the announced policy. In the job order type of industry, particularly where production is of the assembly type, some basic materials may be stocked on the basis of a purchase budget or through the use of stock limits, while parts and materials which are largely special to each job may be purchased only after the customer's order has been received.

**DOLLAR ESTIMATE OF PURCHASES**—Whatever the procedure in providing raw material, an estimate of purchases in dollars by months is essential if a complete budgetary control plan is to be operated. Cash requirements and forecasted balance sheets can be prepared only on the basis of estimated purchases analyzed by months. Normally, the purchase budget is in two parts, one covering direct materials and the other, supplies. While the cost of supplies used is included in the departmental expense budgets, these budgets do not report any estimated changes in the supplies inventory.

Where a company is producing standard articles for stock it is possible to place a large part of the purchasing on a detailed budget basis. By adjusting the estimated material required for the planned production by desired inventories at the beginning and end of a period, the required purchases can be determined. These requirements are then modified by the purchasing department in the light of considerations previously mentioned to provide for the purchase budget. Naturally, such a budget should be subject to revision whenever production varies appreciably from that planned.

**MAXIMUM AND MINIMUM LIMITS**—The most common method of inventory control is the use of stores cards with maximum and minimum limits and order quantities. To be effective, the limits should be under continuous review and modified in the light of the recorded usage of each item of material. Since stock records rather than a detailed purchase budget indicate when material is to be ordered, the purchase budget under this plan is ordinarily not analyzed by types of material, but is stated in dollar amounts for all materials. However, in some cases, stock cards, while used as a basis for notifying the purchasing department when the stock of a raw material is becoming low, do not automatically result in the issuance of a purchase order. By use of a purchase budget based on production requirements, the purchasing department places its orders so that the inventory as a whole is kept in a desired relation to sales. From the purchase requisitions it selects those most urgent to the extent of the purchase allowance then available. Obviously, the minimum limit must be set higher in such cases than it would be where purchasing followed automatically from purchase requisition.

Where speculative buying is engaged in, accurate estimates of purchases by months are impossible, but even in this case there can be some approximation of the date of purchase of specified commodities and their probable prices. For those materials which are purchased only on receipt of customers' orders, there is little object or necessity for a purchase budget, except as an estimate of cash requirements. Usually past experience can be utilized to provide a ratio of material cost to either sales or cost of sales, and a percentage applied to either the sales or production budget. In either case some allowance must be made for lag due to the time the materials are in process.

**LABOR BUDGET**—Unlike raw material, labor cannot be stored until used. Consequently, a detailed production budget ordinarily yields figures for a labor budget without a great deal of calculation. In the process of preparing a production budget, a decision is made regarding the spreading of production, and in the process of applying this decision, labor requirements by types of labor and skills are tabulated. The greatest need for a labor budget arises in those companies with fluctuating sales where the policy of maintaining minimum inventories is practiced. On the basis of labor requirements developed for the production department, the personnel department can prepare a labor budget, taking into consideration various plans for training new men, spreading work, and working overtime when needed. Data on requirements for indirect labor come from the departmental expense budgets.

## Principles of Budgetary Expense Control

**EXPENSE BUDGET TYPES**—Expense budgets may be of three types

- 1 Appropriation or allowance budgets where the purpose is to establish a limit on expenditures for a specific activity
- 2 Forecast or fixed budgets where the purpose is to provide a basis for planning and coordinating activities
- 3 Control, flexible or variable budgets, where the purpose is to provide a set of standards which can be used in the measurement of accomplishments

The above classification is based on the major purpose of each type of budget, and should not be taken to mean that a budget of another type might not be used to accomplish the same purpose. Thus, forecast or fixed budgets are often used for control purposes, but are not as valuable for this purpose as a flexible budget because they fail to make allowance for differences between actual and forecasted volume.

**Appropriation Type Budgets**—Where the effectiveness of an expenditure is difficult to measure, or the need for it is largely a matter of judgment, it is desirable to control such expenditures by deciding in advance just how much shall be allowed. This usually occurs where there is no base against which the expenditure can be measured. Expenditures for advertising are a case in point, the relationship between advertising expenditures and sales volume is not direct, and yet advertising expenditure is a factor to be planned in advance and taken into consideration in arriving at a sales forecast. Probably, advertising budgets of the appropriation or allowance type were the first type of budgets used in American business.

The appropriation or allowance type of budget may also be used to place a limit on expenditures for research or development work, or to limit funds to be invested in new capital additions during the budget period. The appropriation type of budget is most common in governmental budgeting. When used in business budgeting, there is usually more flexibility and a greater opportunity for revision than is found in governmental budgets.

**Forecast Type Budgets**—Expense budgets of the forecast type are more commonly known as "fixed" budgets, a term which is helpful in describing the way in which they differ from variable or flexible budgets. It is, however, a misleading term, since it does not offer a true indication of the nature of this type of budget. Forecast budgets are not 100% fixed, because the established limits may at times be exceeded, this is in contrast to the appropriation budget. Furthermore, the forecast budgets are subject to revision. Their description as fixed arises from the fact that they cannot automatically be adjusted to actual volume, but instead represent a forecast or plan prepared in advance which provides a fixed point from which the actual results are to be measured. Thus a fixed or forecast budget for distribution expenses may be on a sales volume of 1,000,000 units with a forecasted cost of distribution of 50 cents per unit. If actual sales are less than 1,000,000 units, 50 cents may not be a fair standard against which to measure actual selling expenses, because a large proportion of total expenses may consist of fixed charges.

**Control Type Budgets**—A control or flexible budget contains an advance determination of the expense per unit for different volumes of sales. Flexible or variable type budgets are used primarily for expense control purposes. They supplement forecast budgets, thus, in preparing a forecasted profit and loss statement, the amount included for cost of goods sold is based on a forecast of sales and production, with supporting schedules indicating expected costs at the planned production level. Because some costs are fixed and others are variable, unit costs do not vary directly with volume. The real control of costs makes desirable the development of supplementary budgets of the flexible type, so that actual expenditures can be compared with the best measure possible of what the expense should have been for the actual volume of activity experienced.

**CLASSIFICATION OF EXPENSES**—Expenses are usually classified as variable, fixed, and semi-variable. Fixed expenses are those which remain constant in total amount over a wide range of activity. Thus, real estate taxes are fixed expenses which do not change in total amount with variations in the volume of sales or production. Variable expenses are those which tend to change directly with changes in the activity to which they relate. Thus, sales commissions are variable expenses where salesmen are paid on a fixed basis. A 50% increase in sales is accompanied by a 50% increase in commissions. Semi-variable expenses change in response to changes in the activity to which they relate, but do not vary in direct proportion. Where the salesmen are paid a fixed minimum salary plus a bonus based on sales volume, sales compensation varies with sales but not at the same rate. A 50% increase in sales may result in only a 20% increase in sales compensation. (For detailed discussion of Expense Classifications, see Section 17.)

**FORM OF FLEXIBLE BUDGET**—The first problem in the preparation of a flexible budget is to decide the form in which it is to be prepared. Two forms are quite generally used.

- 1 Columnar form
- 2 Tabular form

**Columnar Form**—The columnar form of flexible budget (Fig 17) is really a multiple budget, with budget allowances on standards worked out for several different rates of activity. Klein (N A C A Bulletin, vol 17) illustrates its general arrangement. Budget columns are provided in steps of 5% of capacity, from 50% to 100% of capacity. Each column heading indicates, in addition to the per cent of capacity, the number of direct labor hours at each stage. This form of flexible budget makes possible the setting of definite allowances for each item of expense for each rate of operation shown. Where the actual rate falls between two percentages for which budget figures are provided, either the allowance for the rate of capacity nearest the actual rate may be used, or the allowance may be determined by interpolation. Ordinarily, the first method is sufficiently accurate. Note that in the budget shown in Fig 17, most expenses are of the stair step type, that is, they remain at the same amount for several rates of operations. Thus, the salary of the foreman is set at \$35 for all budgets from 50% to 70% of capacity.

WORKS INDIRECT EXPENSE BUDGETS PER WEEK FOR VARIOUS OPERATING CAPACITIES												W	WORKS		
												A	DEPT.		
REVISED 1/1/-												1 WEEKS		Months	FOREMAN
NO	DIRECT HOURS	1,000	1,100	1,200	1,300	1,400	1,500	1,600	1,700	1,800	1,900	2,000			
01	PER CENT CAPACITY	50	55	60	65	70	75	80	85	90	95	100			
01	Exec & Staff														
02	For m n	35	35	35	35	35	45	45	45	45	45	45			
03	Inspecto s														
04	Clerical	27	27	28	28	29	29	30	30	31	31	32			
05	Tel Superv & Cle	62	62	63	63	64	74	75	75	76	76	77			
06	Orders & Delays														
07	Office & Shop d Cls	10	11	12	13	14	15	16	17	18	19	20			
08	Inter alT anspecti s	7	7	7	8	8	8	9	9	9	10	10			
09	Pro d Adm n														
10	Idle or Lost Time														
11	On d Labor	35	38	41	44	47	50	53	56	59	62	65			
12	Total Direct Labor	52	56	60	63	67	73	78	82	86	91	95			
13	Fuel														
14	Sand														
15	Nails Rods and Wires														
16	B d e d F slings														
17	Grading & Polishing Wheels	4	4	5	5	6	6	7	7	8	8	9			
18	P l s L b c Is & W t	5	5	5	6	6	6	7	7	7	8	8			
19	St No ary & Office Suppl s	1	1	1	1	1	1	2	2	2	2	2			
20	Miscellaneous S pplies	5	5	5	5	5	5	5	5	6	6	6			
21	P cha d Cls or city														
22	Total Op r ing Suppl	15	15	16	17	18	18	21	22	23	24	25			
23	Re IE late														
24	B l s g														
25	M h ary	30	33	36	39	42	45	48	51	54	57	60			
26	M t e	6	7	7	8	8	9	9	10	10	11	11			
27	S m d b l e Tools & Ins	90	99	108	117	126	135	144	153	162	171	180			
28	T l T sp Eq p t														
29	C l g Eq pm t														
30	F t e d Office Appl														
31	Fl s Eq pm t														
32	Patterns														
33	M R e s s Ee pment	4	4	4	4	4	4	4	4	4	4	4			
34	T l Maintenance	130	143	155	168	180	193	205	218	230	243	255			
35	Re gon t f Equip														
36	Post g														
37	T l ph e														
38	T l g ph and Cable														
39	L v t ry Adj sm t														
40	Employ W M	2	2	2	2	3	3	3	3	3	3	3			
41	W d l l y n														
42	D s m d s b c plons														
43	Gr t l s														
44	R t l														
45															
46	M l s e n t E o s	4	4	4	4	4	4	4	5	5	5	5			
47	Total S e	5	6	6	6	7	7	7	8	8	8	8			
48	T l Above Charges	265	282	300	319	338	355	388	405	423	442	460			
49	D p c at o														
50															
51	Tax es														
52	Total F ed Charges														
53	Total all Chrg e														

Fig 17 Columnar Form of Flexible Budget

Allowances of this sort can be more readily indicated on the columnar type of budget than on tabular form

**Tabular Form**—An example of a flexible budget in tabular form is provided in Fig 18. Wonsen (N A C A Bulletin, vol 16) discusses the budget for a company with two factories, "A" and "B". The letters "F" and "V" opposite an item show whether the allowed expenses for a normal month are fixed or variable. In the preparation of a budget for

EXPENSE BUDGET							
Manufacturing Expense—Flexible Budget—Jan June 19—							
Item	FACTORY A			FACTORY B			
	Normal Month's Budget	Fixed or Vari- able		Normal Month's Budget	Fixed or Vari- able		
Budgeted Month's Production	28 500	V		40 000	V		
Salaries							
Administrative	\$ 350	F		\$1 080	F		
Payroll	750	V		811	V		
Orders and tags	440	V		533	V		
Production	180	F		217	F		
Cost	110	F		174	F		
Purchase	160	F		220	F		
Foreman	1 400	F		1 850	F		
Mechanical and General	1 250	V		1 010	V		
Fuel	Total	Fixed	Vari- able	Total	Fixed	Vari- able	
January	750	\$630	\$120	700	\$640	\$160	
February	620	500	120	540	490	150	
March	480	360	120	370	420	150	
April	340	220	120	260	210	150	
May	200	140	120	190	140	150	
June	150	80	120	100	40	150	
Power and Light	550	V		664	V		
Water	25	V		80	V		
Supplies	150	V		180	V		
Machine Parts and Repairs	600	V		828	V		
Repairs to Buildings	60	V		80	V		
Freight and Express Inward	200	V		1 130	V		
Insurance	272	V		840	V		
Office Supplies	180	V		200	V		
Factory Tags	80	V		110	V		
Coupon Tags	20	V		25	V		
Stamps and Dies	20	V		23	V		
Blocks and Cutting Boards	16	V		18	V		
Telephone and Telegraph	75	V		105	V		
Factory Travel	80	V		103	V		
Group Insurance	70	F		70	F		
Reserve for Depreciation of Machinery and Equipment	147	F		120	F		
Reserve for Depreciation of Buildings	278	F		0	F		
Reserve for Local Taxes	483	F		500	F		
Total	\$3 974			\$11 133			
Totals include average month's fuel estimate							

FIG 18 Tabular Form of Flexible Budget



any rate other than normal the fixed expenses remain at the amounts shown but the allowances for variable expenses are recalculated. The rate of operation in this company is measured in terms of pairs of shoes with 28,500 pairs representing normal capacity for Factory A, and 49,000 pairs normal capacity for Factory B. For a month when Factory A produced 26,300 pairs of shoes the allowance for payroll department salaries is 26,300/28,500 of \$750, or \$692.11. Often in the presentation of this type

### BUDGET ALLOWANCES

Unit budget allowances for expenses controlled by the superintendent or foreman and the period total for fixed (Group A) Charges are shown below. Where a curve is needed to obtain the unit budget allowance, it is so noted.

	Unit	Variable Expense Allowances per Unit	Period Allowance for Group A Charges
Rag Room	Man Hour	\$ 43	\$ 400
Rotary Blench	Man hour	70	100
Dimmers	Man hour	54	200
No 1 Washers	Washer hour	45	275
No 1 Beaters	Beater hour	Curve	540
No 1 Machine	Machine hour	5 10	1 100
No 2 Machine	Machine hour	4 05	725
No 1 Loft	Cwt of paper	Curve	150
No 2 Beaters and Washers	Beater hour	Curve	485
No 3 Machine	Machine hour	5 03	1 070
No 2 Loft	Cwt of paper	Curve	175
Loft Cutter	Machine hour	40	100
Roll Pasting	Machine hour	2 55	270
Sheet Pasting	Man hour	78	130
Platers	Machine hour 1 Table	2 40	400
Sheet Calendar	Machine hour	1 30	140
Sorting	Man hour	00	80
Trimming	Machine hour	1 40	130
Sealing	Man hour	5 04	10
Labeling	Man hour	1 33	12
Stack Calendar	Machine hour	1 75	80
Rewinding and Sealing	Machine hour	1 08	80
Finishing Cutter	Machine hour	1 10	140
Finishing Room General	Direct labor dollar	Curve	500
Shipping Room	Man hour	2 63	475
Power Heat, and Light	Paper machine hour	Curve	1 800
Repair Labor	Paper machine hour	1 52	—
Repair Material	Paper machine hour	1 30	—

A chart is maintained for each department which will reflect the relation between the budget and the actual charges for expenses controlled by the superintendent or foreman. On each chart this information will be shown:

- 1 Per cent of difference between actual cost and budget allowances per unit of operation.
- 2 Total actual cost and unit budget allowances for period and for year to date shown in dollars.
- 3 Explanation of differences where margin between actual and budget is more than 10%.

This is a flexible budget. Therefore, changes appearing during the year, such as wage adjustments, setting of new standards or price changes for supplies will be reflected through the change of budget allowances.

STATHMORE PAPER COMPANY

FIG 19 Budget Allowances

of flexible budget, the variable expenses, instead of being stated as an allowed amount for a specified rate of activity, are stated as an amount per unit of output or per cent of capacity.

An illustration of the use of the tabular type of flexible budget to secure control by departments without a detailed breakdown within each department is provided by Fig 19. Wilks describes the flexible budget plan of his company (N A C A Bulletin, vol 17). In this budget, each department allowance is stated in two parts: a variable allowance, and a period allowance which is stated as a fixed amount. The unit used in determining the variable expense allowance is not the same for all departments, labor hours, labor cost, machine hours, and hundred-weight of paper, all are used. In this company for report purposes, the year is divided into thirteen periods of four weeks each. To determine the allowed expense for any four-week period for any department, it is merely necessary to multiply the actual units for the period by the variable allowance and add the fixed allowance. Assuming 480 man hours for the rag room during a four-week period, the variable allowance amounts to \$206.40 (i.e.,  $480 \times \$43$ ) plus \$400 fixed allowance, or a total of \$606.40. Note that in the case of a few departments it is found impossible to reduce the variable allowance to a single rate. In these cases the allowances are plotted on charts, and the reader of the budget is referred to the chart for an indication of the variable allowance for a particular rate of activity.

## Manufacturing Expense Budgets

**PRELIMINARY WORK**—In any company with a modern cost accounting system most work preliminary to the establishment of flexible budget allowances must be completed before budgets can be prepared with such modifications as may be necessary. These preliminaries include

- 1 Proper departmentalization
- 2 Adequate classification of accounts
- 3 Decision as to the unit to be used in measuring productive activity or volume

**Departmentalization**—Costs are controlled by individuals, not by cost systems or budget systems. Some one individual in the organization is made responsible for each item of cost. The first step in placing responsibility is an adequate departmentalization of the factory. In many cases the departmental analysis for cost accounting purposes must be modified, because the purpose to be accomplished is different. For budget purposes the departmental breakdown based on lines of responsibility is essential while for cost purposes the primary object is the securing of accurate costs through the development of departmental or cost center burden rates. For budget purposes a separate department for every foreman or supervisor who has authority to incur expenses for a department or division must be established.

**Classification of Accounts**—It is a fundamental rule of cost control that expenses are to be controlled at their source. Costs secured as a result of accounting prorations are not amenable to control. Accordingly,

the departmental set-up should provide for service departments as well as producing departments and the expense classification should be sufficiently complete and detailed to make possible the assignment of each expense to the department responsible. Each service department should be charged for those expenses over which the department head exercises control, even though for cost accounting purposes these costs are either allocated or prorated to the departments served.

**Measure of Productive Volume or Activity**—Flexible budgets are based on the theory that variable costs and the variable elements of semi-variable costs fluctuate with the volume of production or the rate of operations. The unit used in measuring productive activity is accordingly, most important. For a producing department, units of product such as tonnage, direct labor costs, direct labor hours, machine hours, or standard labor cost or hours, may serve as units for this purpose.

For cost accounting purposes the normal capacity of a producing department is of primary importance, but in budgeting it is more common to make use of potential operating capacity as the 100% basis for a statement of capacity. Thus in a department with ten machines operating on a 40-hour week, the maximum capacity is 400 machine hours. Assuming a 20% allowance for various influences which make the attainment of maximum capacity impossible, the potential or practical operating capacity is 320 machine hours. Using this as 100% other rates of operation can be stated either in terms of machine hours or per cents of potential operating capacity of 320 hours. Thus, 208 machine hours would represent 65% of capacity.

On the principle that costs can best be controlled at their sources, separate budgets are prepared for each service department. In a few cases units of measurement especially applicable to specific service departments can be developed, but ordinarily it is necessary to measure activities of these contributing departments in terms of the combined activity of productive departments.

**SETTING FLEXIBLE EXPENSE ALLOWANCE**—Ordinarily, departmental expense budgets are developed by the budget man in conference with individual foremen, subject to the approval of the plant or works manager. While the average foreman does not have the data or experience to develop a budget without help, his cooperation in the development of standard allowances should be encouraged and his acceptance of them secured. When this is done, management can expect his cooperation in endeavoring to meet or beat standard allowances.

In developing expense allowances for a department for the first time, considerable preparation should precede the conference with departmental foreman. Past data must be analyzed to determine the content of each expense account and its relation to changes in the volume of production. This furnishes a starting point for the analysis and provides a good indication of whether items should be treated as fixed, variable, or semi-variable expense. Ordinarily, semi-variable items cause the greatest difficulty and need some preliminary analysis to determine amount of fixed cost involved and rate of variability. Two methods of making this analysis are illustrated below.

**Use of High and Low Points**—The first method involves the calculation of the rate or degree of variability by comparing the expenses

at two different rates of activity, and calculating the relationship between the increase in activity and the increase in expense. For this purpose figures should be selected for a period of low activity and a period of high activity. Either past actual figures or the best estimates possible of the expenses at the two rates selected may be used. The calculation is as follows:

	Direct Labor Hours	Expense
High rate of activity	4 000	\$530
Low rate of activity	2 000	330
Difference	<u>2 000</u>	<u>\$200</u>

Variable expense =  $200 \div 2,000$  hours = \$10 per hour

The fixed cost component may then be calculated as follows:

	(1) Direct Labor Hours	(2) Variable Rate	(3) Variable Cost (1) $\times$ (2)	(4) Total Cost	(5) Fixed Cost (4) - (3)
High rate of activity	4 000	\$10	\$400	\$530	\$130
Low rate of activity	2 000	10	200	330	130

center within Department A. It makes possible division by responsibilities in sufficient detail to facilitate advance planning by foremen and direct control of actual outlays. The working budget (derived from Figs 20 and 21) is shown in Fig 22. The constant expense becomes the responsibility of the department superintendent and ratios are shown by responsibilities for each class of variable indirect expense.

Fig 23 illustrates the preplanning of expenses for the week beginning March 25 for a departmental direct labor load of \$3,800, of which the load for Production Center A is \$1,800, or just two-thirds of its normal load of \$2,700. At the end of the work week there is prepared a report (not illustrated) in which direct comparison between the budgeted and the actual expenses is made.

**Use of Correlation.**—In the second method for setting expense allowances, this difficulty is overcome by basing the calculation on the experience of a number of periods, for example, twelve months of the past year. The more variable the monthly volume during the year, the

DIRECT LABOR PER WEEK		Zero		\$1,500		\$3,500		\$5,700	
		Hours	Tot. Cost. Amt.	Hours	Tot. Cost. Amt.	Hours	Tot. Cost. Amt.	Hours	Tot. Cost. Amt.
General Supervision Sigs, Apts, etc.		4(40)	\$189 \$109	4 (40)	\$ 189 \$ 189	4 (40)	\$ 189 \$ 189	4 (40)	\$ 189 \$ 189
		9(36)	342 342	9 (36)	418 418	9 (36)	418 418	9 (36)	418 418
Methods Men Inspectors		3(32)	118 118	3 (40)	146 146	3 (40)	146 146	3 (40)	146 146
		1(36)	42 4	1 (45)	53 53	1 (45)	53 53	1 (45)	53 53
Total Supervisory			\$691 \$691		\$ 875 \$ 868		\$ 995 \$ 938		\$1,100 \$ 898
Clonal									
Production Clerks		1(40)	\$ 90 \$ 90	1 (40)	\$ 98 \$ 98	1 (40)	\$ 98 \$ 98	1 (40)	\$ 98 \$ 98
		1(32)		1 (32)		1 (32)		1 (32)	
Stock and Order Cl rks		1(28)	16 16	1 (40)	22 22	1 (40)	22 22	1 (40)	22 22
Cost Cl Ls		1(40)	69 69	1 (40)	77 77	1 (40)	77 77	1 (40)	77 77
		1(32)		1 (32)		1 (32)		1 (32)	
Shop Clerks		1(28)	29 29	1 (40)	37 37	1 (40)	37 37	1 (40)	37 37
Wage Rate Clerks		1(40)	55 55	1 (40)	55 55	1 (40)	55 55	1 (40)	55 55
Other Clerks		1(28)	16 16	1 (40)	23 23	1 (40)	23 23	1 (40)	23 23
Total Clerical			\$275 \$ 75		\$ 439 \$ 312		\$ 715 \$ 312		\$ 876 \$ 312
Helper and Laborers		1(28)	\$ 13 \$ 13	1 (40)	\$ 13 \$ 13	1 (40)	\$ 13 \$ 13	1 (40)	\$ 13 \$ 13
Sweeper		1(28)	175 175	1 (40)	175 175	1 (40)	175 175	1 (40)	175 175
Truck Operator & Supply		1(28)	175 175	1 (40)	175 175	1 (40)	175 175	1 (40)	175 175
Truck Operator & Pits		1(28)	175 175	1 (40)	175 175	1 (40)	175 175	1 (40)	175 175
Sweepers and Pits		1(28)	175 175	1 (40)	175 175	1 (40)	175 175	1 (40)	175 175
Stockkeeper and Helpers		1(28)	175 175	1 (40)	175 175	1 (40)	175 175	1 (40)	175 175
Make a J Repair D on		1(28)	175 175	1 (40)	175 175	1 (40)	175 175	1 (40)	175 175
Misc. Service Labor		1(28)	175 175	1 (40)	175 175	1 (40)	175 175	1 (40)	175 175
Overhaul and Training		1(28)	175 175	1 (40)	175 175	1 (40)	175 175	1 (40)	175 175
Total Service			\$ 13 \$ 13		\$ 13 \$ 13		\$ 13 \$ 13		\$ 13 \$ 13
GRAND TOTAL			\$979 \$979		\$1,094 \$1,133		\$2,439 \$1,133		\$3,253 \$1,133

Up to \$1,500/week D.L. \$ 979 plus \$2.56/D.L. dollar  
Above \$1,500/week D.L. \$1,133 plus \$2.56/D.L. dollar

Fig 20 Variable Departmental Budget for Indirect Labor

## ANALYSIS OF VARIABLE BUDGET

## (a) DIRECT LABOR (All Centers)

Approximate Capacity	Zero	20%	50%	80%
Production Center A	0	\$ 720	\$1 660	\$2 700 (b)
Production Center B	0	260	610	1 000
Production Center C	0	210	490	800
Production Center D	0	310	740	1 200
Total	0	\$1 500	\$3 500	\$5 700

## (b) DIRECT LABOR (Production Center A)

	Number of Employees	Hours per Week	Hourly Rate	Amount
Machine Group (1)	20	40	\$ 80	\$ 640
Machine Group (2)	11	40	80	352
Machine Group (3)	6	40	80	192
Machine Group (4)	3	40	67	80
Machine Group (5)	3	40	70	84
Machine Group (6)	9	40	90	324
Machine Group (7)	10	40	70	280
Machine Group (8)	5	40	80	160
Machine Group (9)	9	40	70	252
Machine Group (10)	10	40	84	336
Total				\$2 700

## (c) VARIABLE EXPENSES (Production Center A) at level of \$2 700 per week for Direct Labor (f)

Helpers and Laborers			
Sweepers	1	40	\$ 20
Truck Operators	5½	40	138
Truck Soap and Supply	3	40	100
Clean Machines and Pits	2½	40	55
Service Conveyor	4	40	80
Total			\$ 393
Make and Resize Dies	7½	40	178
Total Variable Expense			\$ 572
Per Cent of Direct Labor			21 2%

## (d) VARIABLE CLERICAL EXPENSE based on \$2,700 per week for Direct Labor

Cost Clerks	3		\$ 60
Shop Clerks	8		231
Wage Rate Clerk	1		87
Other Clerks	1		24
Total			\$ 382
Per Cent of Direct Labor			6 7%

## (e) PRODUCTION EXPENSE at level of \$5 700 per week for Direct Labor

Production Clerks	3		\$ 88
Stock and Order Clerks	3		98
Stock keepers and Helpers	8		219
Total			\$ 405
Per Cent of Direct Labor			7 1%

FIG 21 Analysis of Variable Budget

WORKING BUDGET			
Normal Labor Load \$5 700 Direct Labor			
Responsibility of	Description	Constant	% of Variable Departmental Direct Labor
Department Supervision	All Constant Expense	\$1 183	
	Supervisory Variable		2 1
	Miscellaneous and Service Labor also Overtime and Training		2 8
Chief Inspector	Variable Inspection Expense		3 1
Production Supervision	Production and Stockroom Expense		7 1
Chief Clerk	Other Clerical Expense		6 7
Foreman of Production Centers A -- D (f)	Variable Production Center Expense		13 7
Total		<u>\$1 183</u>	<u>37 5</u>
(f) VARIABLE PRODUCTION CENTER EXPENSE			
Production Center	Normal Direct Labor Load	% of Production Center Direct Labor	% of Departmental Direct Labor
A	\$2 700	21 2	10 0
B	1 000	11 1	2 0
C	300	10 0	1 4
D	1 200	10 8	2 3
Total	<u>\$5 700</u>		<u>15 7</u>

FIG 22 Working Budget

better the figures for this purpose. To illustrate this method, the figures and description presented by Pinkerton (NACA Bulletin, vol 16) are used. In this example the correlation of telephone and telegraph expense with sales volume is shown. Sales and expense data are presented in the table below.

## SALES VOLUME CORRELATED WITH TELEPHONE AND TELEGRAPH EXPENSE

Month	Sales	Telephone and Telegraph Expense
January	\$ 600 098	\$ 554
February	629 701	541
March	724 340	542
April	800 559	550
May	728 908	508
June	575 441	490
July	282 402	383
August	358 770	379
September	384 041	424
October	239 007	302
November	184 115	337
December	194 908	340
	<u>\$5 718 200</u>	<u>\$5 434</u>

The chart (Fig 24) is based on the figures in the above table and is explained by Pinkerton (as given on page 1284)

**PLANNED EXPENSE**  
 Week Beginning March 25 19—

TOTAL DEPARTMENT Production Center	Direct Labor Week 3/25/—	Allowed Vari- able Expense	Planned Expense
A	\$1 800 (a)	\$ 382 (c)	\$ 405 (b)
B	500	55	50
C	600	60	50
D	900	97	90
	<u>\$3 800</u>	<u>\$ 594</u>	<u>\$ 500</u>
Inspection	\$3 800	\$ 118	\$ 120
Production Supervisor	2 800	270	200
Chief Clerk	2 800 (d)	255	240
Supervisory Variable	2 800	80	80
Service Labor, Overtime Training etc	2 800	106	100
		<u>\$ 820</u>	<u>\$ 826</u>
Constant		1 133	1 133
Total ( $3\ 800 \times 37\ 5 = 1\ 425$ plus $1\ 133 = 2\ 558$ )		<u>\$ 955</u>	<u>\$ 955</u>

PRODUCTION CENTER A	No of Men	Hours	Rate	Amount
(a) Direct Labor Machine Group 1	10	40	80¢	\$ 320
2	11	40	80	352
3	4	40	80	128
4	2	40	67	54
5	2	40	70	56
6	7	40	90	252
Other	7	?	?	632
Total				<u>\$1 800</u>
(b) Indirect Labor				
Sweeper	1	40	50¢	\$ 20
Truck Operators	4½	40	62½¢	118
Truck Scrap and Supply	8	40	50	60
Clean Machines and Pits	1½	40	55	33
Service Conveyor	3	40	50	60
				<u>\$ 296</u>
Make and Remove Dies	5	40	60	120
Total				<u>\$ 406</u>
(c) Allowed Indirect Labor ( $\$1\ 800 \times 21\ 2\%$ )				\$ 382
Excess of Planned Expense over Budget				\$ 24
(d) Clerical Expense (Chief Clerk)				
Direct Labor (All Production Centers)			\$3 800	
Allowed Variable Clerical Expense			$\$3\ 800 \times 6\ 7\%$	$= \$255$
Planned Clerical Expense				
Cost Clerks	2(32)		\$ 52	
Shop Clerks	6(40)		174	
Wage Rate Clerks				
Other Clerks	1(32)		20	
			<u>\$ 246</u>	
Excess of Budget over Planned Expense				\$ 9

FIG 23 Planned Expense for Week



Our assured monthly schedule of telephone and telegraph expense showed \$554 of expense in January with \$606 098 of sales. At the point on the chart where the horizontal line representing the amount of expense meets the vertical line representing the volume of sales we placed a dot surrounded by a circle to make the dot more easily visible. This dot indicates not so much that the telephone expense was \$554 in January as that this expense was \$554 for \$606 098 sales.

Similarly we place a dot at the intersection of the \$541 expense line with the \$629 701 sales line to indicate the February expense. Note that in this month the expense was less although the sales went up.

The other ten dots are then placed in the same manner. When they are all placed the dots representing the various months will appear from left to right not in the chronological order of the months, but in the order of sales volume.

Although the thoroughly natural trend of increase in expense as sales volume increases is clearly defined a curve indicating this trend would not start at zero of expense for a zero of sales. This means that there is a

### TELEPHONE AND TELEGRAPH EXPENSE

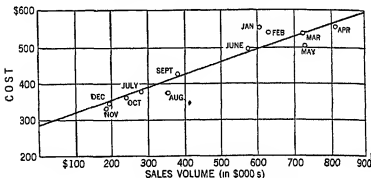


FIG 24 Correlation in Setting Expense Allowances

fixed minimum of cost a nonvariable factor, which must be ascertained. Anyone at all acquainted with commercial operations will understand why this is so.

The next step is to ascertain the amount of this nonvariable factor. In these preliminary steps which we are taking it is sufficient to lay a straight edge preferably a transparent one along the dots in such a way as to project as exactly as possible the trend which they show. To my eye, this straight edge crosses the zero line of sales at \$285. If to your eye it crosses slightly above or below this point, I shall not argue with you. This amount of \$285 is then the nonvariable element in the semi variable item of telephone and telegraph expense.

What is the purely variable element, each semi variable cost being made up of a nonvariable and a variable element? The total expense for the year was \$5 434. The nonvariable expense was \$285 per month or \$3 420 for the year, leaving a variable element of \$2 014. Latter amount divided by the year's sales volume of \$5 718 200 indicates a variable element of 0.352% of sales and the normal telephone and telegraph expense at any monthly volume of sales is \$285 plus 0.352% of that sales volume. At \$900 000 of

monthly sales it will be \$602. Placing a guide mark on the chart at the intersection point of \$602 expense with \$400,000 of sales we can draw our line or standard between that guide mark at the right and the \$285 of expense at zero sales at the left.

Another application of the correlation technique is presented below. It is in reality a combination of correlation and the use of high and low points. Martin (N.A.C.A. Bulletin vol 20) describes a flexible budget procedure for the control of indirect labor costs. The measuring stick selected is direct labor dollars as the index of departmental activity. Procedure is as follows:

Determine for the department the probable range of production level (direct labor load) likely to be realized within a reasonable period of time, two years for example, then choose the minimum and the maximum labor load which will include the previously determined range and at the same time cover a range of not less than 50% of the direct labor capacity of the department. Next choose at least three intermediate labor loads one of which is approximately the same as the current labor load. These five labor loads determine the allowable indirect labor at a particular labor load level. An example for a particular department "A" might be as follows:

	Dollars per Week
Current direct labor load	\$ 6 000
Capacity direct labor	10 000
Probable range over two years	\$4 000- 8 000
Budget points	\$3 000-4,500-6,000- 7,000- 8 000

Next prepare a budget of indirect labor load similar to that shown in Fig. 25.

The number of employees is shown wherever possible and the amount of expense is the aggregate of their weekly pay. When services such as maintenance are rendered by a central service department, it is not possible to visualize the expense in terms of number of people, but only in probable amount of charge. All values shown represent the composite judgment of the department head and his functional supervisors and before final adoption, must be approved by the management. The figures represent the optimum indirect labor under normal operating conditions as nearly as can be determined by present knowledge, methods and equipment and conformance with long term management policies and strict exercise of economy.

Martin describes the procedure to provide for setting flexible budgets when the actual production falls between the budgeted levels of production, as follows:

We have now planned indirect labor, i.e. set optimum standards at five levels of production. By plotting the values shown in rectangular coordinates with indirect labor as the ordinate and direct labor as the abscissa it is possible to determine an empirical mathematical relationship between indirect labor and direct labor. A simple equation representing a straight line shows the average trend indicated by the plotted points, and is the most practical relationship because of its simplicity. It also is generally quite accurate throughout any normal range of operation say between 30% and 90% of capacity. The simple equation expressing the trend of optimum indirect labor is then a fixed amount per week plus a factor times the weekly direct labor. Below about 30% of capacity necessity may dictate the elimination of some activities and drastic curtailment of others which are profitable at a reasonable load. The projection of the chart to

	No of Empl	Amount	No of Empl	Amount	No of Empl	Amount	No of Empl	Amount	No of Empl	Amount
<b>DIRECT LABOR</b>	100	\$3 000	150	\$4 500	200	\$6 000	250	\$7 500	300	\$9 000
INDIRECT LABOR ACCOUNTS										
General Supervision										
Salaries Foremen										
Inspections										
General Assistants										
Supervision Total	10	525	13	625	14	715	16	805	18	890
Production Clerks										
Stock Clerks										
Cost Clerks										
Time and Shop Clerks										
Dispatchers										
Planning Clerks										
Other Clerks										
Clerical Total	21	715	27	865	34	1 060	43	1 250	50	1 460
Helpers and Laborers										
Crank Operators										
Stockkeepers										
Tool Crib Attendants										
Service Total	25	550	31	680	38	835	44	960	50	1 065
Overtime Direct Labor										
Overtime Indirect Labor										
Training Employees										
Unassigned Time										
Idle Time etc Total		63		94		126		158		180
Non-durable Tools										
Shop Supplies										
Rearrangement										
Other Operating Expense										
Tools etc Total		106		151		196		241		286
Maintenance of Buildings										
Maintenance of Misc Shop Equip										
Maintenance of Electrical Apparatus										
Maintenance Overtime										
Maintenance of Special Tools										
Total Maintenance		563		790		967		1 064		1 231
Total Indirect Labor		2 537		3 145		3 829		4 478		5 142

[Detailed figures purposely omitted.]

FIG 25 Budget of Indirect Labor

the zero direct labor point is only for the purpose of determining graphically the fixed portion of the equation. The indicated fixed indirect labor then has no significance other than as a factor in the empirical equation used to interpret indirect labor requirements within a reasonable operating range. During periods of extreme business depression factors other than actual requirements influence management policy relative to expenses.

**CONSULTATION WITH DEPARTMENT HEADS**—The next step is for the budget man to discuss these allowances with the department foreman. If he is using the tabular form of budget, his job is to get an agreement on the amount of each budget period for each fixed expense and the fixed element of the semi-variable expense and the rate of variation for each variable expense and the variable portion of each semi-variable expense. Where semi-variable expenses of the stair-step type are involved, a decision must be reached on the point at which each new increment must be added and the amount of each increment. Where the columnar type of form is used, it is best to develop first a budget for the rate at which the department is working at the time. In discussing each expense item with the foreman, an opportunity is provided to question the necessity for each expense and the justification for current rate. According to Klein (N.A.C.A. Bulletin, vol. 17)

All expenses of the department item by item will then be reviewed by the budget man and the foreman. The function of every indirect worker will be questioned. Can certain routines be eliminated, curtailed or simplified? How about the various supplies used? Would greater care in their use result in economies? Was the foreman previously aware of the cost of the supplies he may have used so freely in the past? What is the condition of the productive facilities and the probable maintenance work that will be required if operations continue as at present?

These questions and others like them give the budget man and the foreman an opportunity to decide to what extent the expense experience of past periods can be adjusted in setting up budget allowances. Labor rate changes and the current price level for supplies are given careful consideration. In connection with the study of facilities any unusual repairs or maintenance needs may be anticipated. This review with the foreman of expenses to be allowed at the current rate of operations also provides a basis for arriving at the allowance to be set for other operating rates. Where the expense is completely fixed, the same allowance is inserted in the budget columns for all rates of capacity. Where the expense is completely variable, the variable rate can be based on the allowed expense for the current rate, divided by per cent of capacity at current levels. This unit cost for each per cent of capacity multiplied by the per cents shown for each column of the budget provides the allowances desired. The budget man reviews with the foreman the figures resulting from his analysis of fixed and variable elements of semi-variable expenses, and discusses the possibilities of reducing the fixed amount or the variable rate. Many expenses are not fixed or variable by nature, but acquire such a classification as a result of decisions made at budget conferences or due to policies established by management. Once the budget man and the foreman have reached an agreement regarding the allowance for each item of expense for each rate of output, the budget is ready for submission to the plant manager for his approval.

## Budget for Distribution Costs

**NATURE OF PROBLEM**—Production costs are controlled by predetermining what the expenses should be for each volume of production and comparing actual expenses with these predetermined standards. In somewhat the same way the control of costs of distribution involves a predetermination of the cost of the sales campaign which the management feels will produce the largest net return (not necessarily the largest sales) and a comparison of actual costs with those forecast. In a few cases and for a few items of distribution cost, it has been found possible to apply the principle of the flexible budget, but for distribution costs generally, the problem is not one of relating costs to sales volume, but rather one of carrying out the sales campaign within the expense allowance provided by the budget.

Responsibility for the preparation of a distribution cost budget rests with the executive in charge of sales. The planning of the sales campaign is his responsibility and a completely planned campaign only needs to be translated into dollars to provide a distribution cost budget. The budget director and the accounting department provide the assistance needed in translating sales plans into a budget and in interpreting the various elements of the plan by estimating their effect on the final net profit. Naturally, the planning of the sales campaign and forecasting the sales volume are carried on concurrently; neither sales volume nor distribution costs can be independently forecast.

**CLASSIFICATION OF DISTRIBUTION COSTS**—The first step in the preparation of a budget of distribution expenses is analysis of the distribution activity by functions, subfunctions and details of subfunctions. This makes possible a review of the cost of each in terms of the results which are forecast. The classification of distribution costs depends on the organization of the sales department and the way in which goods are sold. The following classification is fairly representative.

- |                                   |                  |
|-----------------------------------|------------------|
| 1 Advertising and sales promotion | 5 Transportation |
| 2 Direct selling                  | 6 Financial      |
| 3 Sales administration            | 7 Clerical       |
| 4 Warehousing and shipping        |                  |

The first of these, advertising and sales promotion is often handled by a separate department with its own budget, and for that reason is considered separately later.

Once the distribution activity has been broken down by functions and subfunctions, it becomes possible to analyze the various expenses in terms of their relation to the sales volume and to the sales program which is being developed. Some expenses like administrative salaries are fixed and decisions of the sales management on, for example, the number of office employees and their salaries sets the budget allowance. Others vary with certain factors which become clear as the sales plan develops. Traveling expenses of salesmen can be forecast with some degree of accuracy once a salesman's route has been planned, distance to be traveled determined, and the travel costs of the territory consid-

eted Over-all standards are difficult to develop because of differences between territories. Some elements of expense are found which tend to vary directly with sales volume, so that the determination of the allowance is based on the final sales forecast.

It is also necessary that the total budget when developed be analyzed by territories, and, if possible, by lines of products. This makes possible a review of the ratio of distribution costs to sales income by territories and product lines to indicate weak spots in the distribution plan. Such analysis also provides territorial budgets and budgets by product lines for later use in measuring accomplishment.

**ADVERTISING AND SALES PROMOTION**—Many companies which do not have complete budgetary control systems nevertheless control expenditures for advertising and sales promotion by means of an allowance or appropriation, by providing a predetermined limit for expenditures of this class. The question arising in connection with such a budget is whether the appropriation should be in the form of a lump-sum allowance or should provide detailed appropriations for specific purposes. In most cases the setting of spending limits in any detail is likely to be disadvantageous. Details in connection with the original estimates make planning necessary provide a basis of information for judging the desirability of an expenditure make possible a later comparison of actual with budgeted expenditures, and in some cases provide information on advertising and sales promotion costs by lines of products or territories. The latter is needed in judging in advance the possible profit or loss involved in various proposed actions. However, once the details have been used to arrive at a lump-sum appropriation for advertising and sales promotion it is best to treat the details as forecasts only, and so long as the advertising department stays within its lump-sum total, to place no limits on expenditures for definite purposes.

In advertising, the important item of cost relates to advertising media, as much as 85% of the total advertising expenditure being made in this way. Media available include magazines, newspapers, radio programs, direct mail, trade papers, outdoor advertising, car cards, dealer cards and window displays, conventions and exhibits, free goods and samples and sales and service literature. Contracts with advertising agencies are usually made, and major advertising campaigns planned for several months ahead, and considerable information on advance commitments is available at the time the advertising budget is prepared. By completing plans for a budget period with respect to media to be used and the nature and extent of advertising through each medium, the major portion of planning for the advertising budget is completed.

In addition to the cost of media, there are administrative expenses and advertising production costs. Administrative expenses are almost entirely fixed and involve largely questions of salaries for the budget period. Production costs tend to vary with the cost of media, but since some fixed costs are involved they should be budgeted in detail. Normally, the advertising and sales promotion budget is prepared by the executive in charge of advertising and passed on by the sales manager before being submitted to the budget committee. In some companies provision is made for consideration and final decision by the board of

directors According to a survey made by the Association of National Advertisers, the most common method used in determining the advertising appropriation is to estimate the amount needed for an adequate campaign, although many companies were basing their allowances on the volume of sales for the past period or the expected volume for the budget period If the board of directors establishes a policy of allowing a per cent of past or prospective sales for advertising, the working out of details can be left to regular budgeting procedure Where the amount to be appropriated is based on an estimate of the sum needed for an adequate advertising campaign, the board of directors or the budget committee should function as a check on the enthusiasm and ambition of the advertising manager

In addition to the budget for the period there should be prepared a series of monthly budgets, for use in calculating cash requirements Normally, this is not difficult because advertising is planned for definite dates and administrative and production costs are made up largely of salaries

**ADMINISTRATIVE EXPENSE BUDGET**—Complications involved in preparing the administrative expense budget are few, and the area covered is generally well known Administrative expense budgets are usually of the forecast type and are based largely on past experience The most important item to be included is salaries Where a company has a well-defined salary policy and all adjustments of salaries are considered before the beginning of the budget period, the most likely variable to arise results from increases or reductions in administrative personnel Most other items included in the administrative expense budget may be forecast on the basis of past experience modified by any prospective changes in the organization or the available income

## Financial Budgets

**PLACE IN COMPLETE BUDGET PLAN**—Sales production and expense budgets previously discussed are all parts of what is usually called an **operating budget** Summarized they provide a forecast or budgeted profit and loss statement for the budget period and for each subdivision of it It is a relatively simple matter to go one step further and apply advanced planning and control to the financial affairs of the business The principal budgets required relate to plant and equipment and to cash Thus it becomes necessary to control the investment in durable equipment Once an operating budget has been prepared forecasting the cash receipts and cash disbursements is merely a matter of reflecting the effect of the forecasted transactions on a concern's cash balance and balance sheet This necessitates planning for the following objectives

- 1 Use of available funds
- 2 Securing temporary loans
- 3 Repayment of such loans
- 4 Financing expansion
- 5 Planning for taxes, interest payments and dividends

Since changes in all balance sheet items must be considered in arriving at financial budgets, the preparation of a forecasted balance sheet for the end of the budget period becomes a logical final step. Thus all financial and operating activities are brought under control through advanced planning and coordination of activities.

**PLANNING INVESTMENTS IN PLANT AND EQUIPMENT**—In many industrial companies the largest item on the balance sheet in point of value is investment in plant and equipment. Long time planning is of particular importance in connection with these investments. The justification for such investment must be based on the expected utilization of the capacity over a relatively long period necessitating long time forecasting of the demand for the product manufactured. Without such planning, the temporary need for increased facilities during periods of peak activity leads to overexpansion and unwise investment. Naturally, this long-time planning cannot be carried on in great detail, nor can a plan made years in advance be expected to stand without revision. But a long-time program gives perspective and provides a starting point for a short term plant and equipment budget, prepared for a year or a six month period.

The plant and equipment budget contributes to the complete budget set-up in the following ways:

- 1 It provides a basis for estimating the cash requirements for additions, replacements and renewals not charged to operations.
- 2 It provides a basis for estimating any cash receipts to be realized from plant and equipment to be disposed of.
- 3 It provides a valuation of plant and equipment for a forecasted balance sheet.
- 4 In some cases it provides estimates of depreciation and maintenance costs for inclusion in departmental expense budgets.

**Developing Plant and Equipment Budget**—Responsibility for the development of a plant and equipment budget varies with the nature of the organization. So far as manufacturing operations are concerned the plant manager or engineer normally provides the original estimates or requests for appropriations. The sales manager may be responsible for estimates relating to delivery equipment, trucks, salesmen's automobiles, and similar assets required by the sales department. The office manager may have the same responsibility with respect to office furniture and fixtures. Normally these estimates of equipment requirements are summarized by the budget director, passed on by the budget committee and in many cases presented to the board of directors for final action. In this process, the treasurer participates in the deliberations to assure that investments agreed upon are in line with funds available for this purpose.

The first step in the development of the plant and equipment budget is the preparation of the departmental requests. These should be made in some detail, and should indicate at least the following:

- 1 Description of project
- 2 Whether an addition, renewal or replacement
- 3 Justification for expenditure
- 4 Summary of estimated costs, and estimated value of recovery from any assets discarded



- 5 Proposed date of acquisition or the date of starting and completing if a construction item
- 6 Estimated cash requirements by months

**Justification of Expenditures**—Each request for an authorization for investment in plant and equipment should be supported by a statement justifying the investment which is requested. The justification may be on grounds of increased income or decreased costs sufficient to pay for the asset and yield an adequate return over the average investment during its period of use. One procedure for selecting investments was outlined by Freeman (N A C A Bulletin, vol 18) as follows:

Every business should develop a policy in respect to replacements and expansion. It should make a systematic study of the efficiency of its equipment and attempt to forecast the probable range of its sales and cash requirements for at least several years ahead. Instead of spending for whatever is thought of first it should lay out a long range program and select its investments according to merit. A good procedure is to list all proposed investments or classes of investments showing the following estimates for each:

- 1 The cost of investment proposed i.e. of long life asset and its installation and of any other initial expense in connection with proposal (e.g. moving) which has not been deducted from the value of the expected benefit. If there is any salvage or turn in price for any asset supplanted, the cost of the investment would be reduced by the amount to be so received or credited.
- 2 The average value per year of the expected benefit i.e. either an increase of revenue or a reduction of cost or contingent loss of revenue. If some of the values, costs or risks are so intangible that they cannot be expressed in figures they should be explained in footnotes.
- 3 The number of years the benefit is expected to continue figured conservatively, but not so conservatively as to interfere with progress.
- 4 The annual contribution which the average value of the expected benefit must pay toward the cost in order to have the cost all paid for (except for its salvage or turn in value) by the time the life has elapsed.
- 5 The net profit per year from the proposed investment i.e. the excess of the value over the required contribution.
- 6 The average investment during the period. This would be one half of the sum of the investment at the beginning and at the end (salvage or turn in value). If the value at the end is negligible this will be approximately one half of the cost of the investment.
- 7 The percentage of profit on the average investment, i.e. percentage that (5) is of (6).

The proposed investments can then be arranged on the list according to the percentage of expected profit with the highest percentages at the top and the lowest at the bottom. If any intangible values, costs, or risks have not been considered the manager can change the priorities of the items affected. The available capital can then be assigned to the items on the list, starting at the top and working down as far as the available capital will permit, but not lower than the percentages justify its use.

It is common practice in connection with a plant and equipment budget to require that those requesting investments in plant and equipment classify their proposals on some such basis as:

- 1 Essential
- 2 Profitable
- 3 Desirable

A further classification is often made with respect to the period over which expenditure is to be made. As an example, projects may be analyzed into

- 1 Those started in a past period to be completed in this period. These having been authorized previously are in an essential classification.
- 2 Those to be started and completed during budget period.
- 3 Those to be started during budget period and completed in a subsequent period. The authorization must cover the project as a whole but the budget includes only the estimated expenditures for the forecasted period.

The next step is for the budget director to present the departmental request to the budget committee. Here the desired investments are scrutinized with regard to their need and profitability and related to the funds available for investment. Normally the recommendations of this committee are referred to the board of directors for final approval.

**Release of Appropriations.**—To be fully effective any system of budgetary control of investments in plant and equipment must be tied in with a procedure for detailed control of expenditures. The budget authorization usually does not mean that a department head is free to go ahead with every project included in the budget. In many companies a procedure for securing authorization of expenditures has been developed, with the rank of the individual authorized to approve requests depending on the size of the expenditure contemplated. Where a project has not been included in the budget approval of an officer of higher rank may be required than in the case of budgeted projects. Upon the authorization of a project, costs are accumulated by project or authorization numbers, and frequent reports rendered showing actual costs compared with budgeted or estimated costs. At the completion of each project, a complete report of actual versus budgeted costs is prepared.

In some companies, excess expenditures on one project serve to reduce the balance available to that department for other projects, while a saving becomes available for other purposes. In addition to these reports, it is desirable that checks be made from time to time to see to what extent the savings or increased earnings set forth in each investment request have actually been realized.

**CASH BUDGET.**—There is no uniformity of terminology in describing the budget which summarizes the expected financial transactions of a business. In some cases it is called the cash budget; in others the financial budget. But the term "cash budget" is also used to designate a summary of expected cash receipts and disbursements prepared by converting forecasts contained in operating budgets from an accrual to a cash basis. The term "financial budget" is also used to refer to the planning of cash and financial transactions involved in

- 1 Borrowings and their repayment.
- 2 Asset replacements and additions.
- 3 Dividends.
- 4 Investments in marketable securities.
- 5 Changes in funded debt, capital stock, etc.

When this division of the financial budget is observed the preparation of a cash budget is largely mechanical. It is based on a translation of

the items of income and cost forecast by the operating departments into cash receipts and disbursements. In this connection it is necessary to take into account the average lag between a transaction and its reflection in cash receipts and disbursements. In some cases, operating departments are requested to forecast cash receipts and disbursements by periods, but more commonly these forecasts are prepared by the budget director or the treasurer from departmental forecasts of income and expense. However, planning of those cash receipts and disbursements which are not directly related to operations is distinctly a job of financial management, for which the treasurer is primarily responsible. In addition to review by the budget committee, these financial plans often need approval by the board of directors.

CASH BUDGET				Year 19__	
Item	January	February	December	Total	
<b>CASH RECEIPTS</b>					
Net Income					
Depreciation					
Accrued Taxes					
Federal Income					
State Income and Franchise					
Federal Capital Stock					
Real Estate					
Excess Collections over Sales					
Inventory Reductions					
Liquidation of Securities					
Accrued Advertising Expense					
Collections on Mortgage Receivable					
<b>TOTAL RECEIPTS</b>					
<b>CASH EXPENDITURES</b>					
Tax Payments					
Federal Income					
State Income and Franchise					
Federal Capital Stock					
Real Estate					
Advertising Expenditures					
Dividends					
Capital Expenditures					
Purchase of Securities					
Liquidation of Accounts Payable					
<b>TOTAL DISBURSEMENTS</b>					
<b>LOSS OR GAIN IN CASH</b>					
<b>SUMMARY OF CASH FORECAST</b>					
On Hand beginning of period					
Loss or Gain					
Bank Loans					
On Hand end of period					
NOTE: Cash receipt item entitled Excess of collections over sales is inserted in red if sales exceed collections. The same principle applies to inventory reductions and liquidation of accounts payable.					

FIG 26 Cash Budget

**Cash Forecast**—The cash budget is largely an instrument for forecasting and planning rather than a basis for control. Two methods most commonly used in preparing a cash forecast are

- 1 Cash receipts and disbursement method
- 2 Adjusted income method

Under the first method operating budgets are used as a basis for forecasting in considerable detail the cash receipts and disbursements resulting from budgeted operations. (See later discussion on Accounts Receivable and Cash Disbursements.) Under the adjusted income method of preparing a cash forecast, the expected net profit or loss shown by the forecasted profit and loss statement is adjusted by

- 1 Elimination of all noncash income and expenses
- 2 All forecasted changes in the balance sheet affecting cash

In this way it is possible to arrive at a source of net increase or decrease in cash much in the same way as a statement of funds and their application is prepared. Fig. 26, from a report "The Cash Budget" by the Policyholders Service Bureau of the Metropolitan Life Insurance Company illustrates the form in which a budget of this type might be prepared. There are two considerations which limit its usefulness for forecasting cash receipts and expenditures in a highly seasonal business.

- 1 It is difficult to allow for lag between sales and collections on one hand and expenditures and disbursements on the other. The method is based on the theory that the adjustment of the current period's forecasted profit provides the net increase or decrease in cash for the same period. In companies where sales vary widely from one month to another or expenditures increase or decrease considerably at certain periods of the year the failure to allow for this lag can only result in an improper allocation of cash receipts and disbursements among periods.
- 2 The method lacks detail making it difficult readily to compare actual cash transactions with those expected.

**FORECASTING CASH RECEIPTS**—Cash receipts come from a variety of sources such as accounts receivable collections, cash sales, interest and dividend earnings, proceeds from sales of capital assets, new financing, etc.

**Collection of Accounts Receivable**—In an industrial company, collections of customers' accounts constitute the principal source of cash receipts. A forecast of such collections logically depends on a sales forecast, but in addition it also depends on the length of the collection period. The sales forecast prepared by the sales department provides the information on expected sales. This is analyzed by months or even weeks in some cases, cash and credit sales being shown separately.

**Length of Average Collection Period**—The length of the collection period represents the time lag between the date of sale and the date of collection. An average collection period can be determined by calculating the number of turnovers of accounts receivable during the year and translating this into the average length of time required for a single turnover. Thus, in a company with average credit sales of \$1,800,000 and an average accounts receivable balance of \$150,000 the rate of turnover of accounts receivable is 12 per year, so that a single turnover would take 1/12 of a year or one month on the average. In other words col-

lections in this case would be made approximately one month after the date of sale, and collections of any single month would approximate the net credit sales of the preceding month.

In those companies where sales follow a highly seasonal pattern the length of the collection period is likely to be longer at some periods of the year than at others. In such a company an average annual collection period has only limited usefulness in estimating collections on charge accounts. Calculations of a separate collection period for each month results in more accurate forecasts. This can be accomplished on the basis of past experience by dividing the accounts receivable balance at the end of any month by the average daily sales for that month. The result is number of days' sales uncollected at the end of the month. In order to use this information as a basis for forecasting it is convenient to convert the number of days' sales uncollected at the end of a month into a decimal fraction of a month. Thus, if past experience indicates sales of 22 days uncollected at the end of a 31-day month,  $709677$  month is decimal equivalent of 22 days. Multiplying the forecasted sales for the month by this fraction provides the expected balance of receivables at end of the month. Thus collections may be forecast by adding together the receivable balance for the beginning of the month and the forecasted sales for month and deducting from this total the forecasted receivables at the end of the month. Of course, allowance must be made for average discounts granted, and in case gross sales have been used as basis for the forecast, adjustments also for expected sales returns and allowances. In addition in carrying forward the accounts receivable balance from one month to another, the balance forwarded is reduced by the expected uncollectible amounts included therein.

In forecasting the length of collection periods, as in other types of forecasting past experience is the best available guide to future expectations. But it is not the only factor to be considered. Such occurrences as an early or late Easter, a change in governmental policy concerning, for instance, relief or farm programs, a season that is warmer or cooler than normal, or other occurrences which affect receipts or periods in which collections are made by wholesalers and retailers may have considerable effect on collections of a manufacturer. So far as this information is available at the time a forecast is made, it should be taken into consideration and the forecasted collection period modified accordingly.

**Other Sources of Cash Receipts**—In addition to collections of customers' accounts other sources of cash receipts must be considered. Customers' notes receivable have definite due dates and provide no particular problem in the average company with a background of past experience. Interest and dividends on investments provide other sources of cash receipts which can be forecast with reasonable accuracy.

**FORECASTING CASH DISBURSEMENTS**—Information on expected cash disbursements is developed from operating budgets

- 1 Production costs
  - a Material and supplies, from the purchasing budget
  - b Factory payroll from labor or payroll budget
  - c Factory expenses from departmental expense budgets
- 2 Distribution costs, from selling expense and advertising budgets
- 3 Administrative expenses from administrative expense budget
- 4 Financial expenses from administrative expense budget

Combining these with a forecast of cash receipts results in a forecast of cash balances for any desired number of periods ahead. The principal difficulty in utilizing these budgets to forecast cash disbursements is the existence of overlapping or duplication. Supplies used and indirect labor costs incurred appear in the expense budgets of the operating departments but may also appear in the purchase budget and labor budget. As a general rule it is preferable to base the calculation of these disbursements on the purchase and labor budgets, provided of course that all indirect material and labor costs are included in these budgets. Particularly in the case of supplies some of which may be charged directly to production while others are placed in stock it is important that the purchase budget be used as a source of data.

Credit terms and the policy of a company with respect to payment of bills are primary considerations in utilizing the purchase budget of raw materials and supplies to determine expected cash disbursements for materials. Where cash resources permit and a general policy of paying all bills within the discount period prevails credit terms are the primary consideration. If the terms granted by different vendors vary, it is necessary to classify expected purchases by credit terms or develop an average lag between the date of the invoice and the date of payment based on past experience, modified by any anticipated shift as between vendors.

Using the labor budget as a basis, determination of expected cash disbursements for payroll is largely a matter of adjusting accrued labor costs for the unpaid balance at the beginning and end of the period. With each payroll date known, and the estimated labor cost for each month available from the labor budget, the schedule of expected cash disbursements for payrolls can be set up as follows:

	Weekly Wages	Semi Monthly Wages	Monthly Salaries
Accrued December 31	\$	\$	\$
January labor costs per labor budget			
Total payroll liability	\$	\$	\$
Payments during January			
Accrued, January 31	\$	\$	\$
February labor costs per labor budget			
Total payroll liability	\$	\$	\$
Payments during February			
Accrued February 28	\$	\$	\$

The remaining cash disbursements to be estimated from the departmental expense budgets are relatively few and most of these have definite dates of payment. This is true of insurance and taxes. Purchased power and water and a few similar items paid monthly require an estimate of the date of payment in each month.

The required cash outlays for selling and administrative expenses and the expected payment date are estimated in much the same way. Salaries and commissions make up a large part of the total, and determination of the amounts to be paid each month can be based on a consideration of the pay days in each month. Financial expenses can usually be forecast rather accurately, except for interest on any new borrowings which may be decided upon after the need for them has been

determined from cash budget. Items of this sort can be included by a later revision of the estimates. Income taxes based on income of the prior year can be estimated with a fair degree of accuracy and dates of payments are, of course, definite. Statement No 6 (page 1306) shows a simple form for the presentation of a cash forecast.

**Financial Planning**—Financial planning involves questions of cash needs and cash utilization. Should the cash budget reveal the need for short-term financing, arrangements need to be made with the bank. A complete set of budgets is of real value in making such arrangements. Long term financing may also be necessary where the cash budget indicates that the available cash balance is not sufficiently large to permit the desired expansion. One of the most important uses of the financial budget is the balancing of the need for investments in plant and equipment with cash resources available. In addition any changes in the funded debt or outstanding capital stock need to be considered. In some companies with amply liquid resources, an important part of financial planning relates to the investment of excess funds during periods when they are not needed. Such investments may be planned with considerable accuracy where complete financial budgets are used. An illustration of how one company uses its financial budget for planning purposes has been provided by Foster (N. A. C. A. Year Book, 1932).

In looking through our estimated cash balances for the next six months we find a few large payments but they are small compared with what they were when we had a \$30 000 000 per year construction program. Here in the month of June I find a federal income tax payment, and as major items payments to General Electric Westinghouse and a \$125 000 insurance premium. On the first of July I find an item of \$250 000 interest on mortgage bonds. On the 15th there is a dividend of \$2 500 000. In the latter part of the month we will pay the city of Detroit about \$1 500 000 in taxes. In order to do that we have some invested funds that mature on the 25th of July. We found a few months ago that those funds were available for 90 days, and we were able to invest them at 3% . They will due in time to meet the taxes.

In looking over the first of August we find another item of \$1 625 000 interest on bonds. Every day during August we pay taxes to the municipalities in this territory. The total is over \$500 000.

That is the way it goes on down through, right up to the end of the year. But with the budget estimates as guides we are able to plan in advance and meet all financial requirements.

The length of the budget period depends on whether the budget is a short-term or a long-term financial budget. In a seasonal business there are periods of peak business when borrowed funds are needed and periods of rather complete liquidation when bank loans can be repaid. In some industries this is an annual cycle, and for companies in such industries an annual budget is needed to provide a picture of a complete cycle of financial transactions. However there are many industries which have both a spring and a fall season, so that a six-month budget covers a complete cycle of financing. Thus, the seasonal characteristics of a particular business are often the determining factor in deciding the period of time to be covered by the long-term budget. In addition a short-term budget on a monthly basis or on a quarterly basis analyzed by months is desirable for current planning of financial affairs. Since it does not serve as a standard for measuring efficiency, there can be

no objection to its frequent revision. A convenient arrangement is for the short-term budget to be prepared on a quarterly basis by months with a new month added as each month is completed. At the time the forecast for the new month is added, the figures for the two earlier months are revised in the light of information then available.

In addition to the revision of the short-term budget the long-term budget is revised whenever the departmental budgets upon which it is based are adjusted in any way. Such revisions of the long-term cash forecast may often indicate needed changes in the financial plan making up the second part of the financial budget.

## Summary Budgets

**FORECASTED BALANCE SHEET**—In some companies it is the practice to limit the budgeting of financial transactions to the preparation of a cash or financial budget. However, little additional work is required to prepare a forecasted balance sheet. In the preparation of operating and cash budgets, most balance sheet items have already been forecast. A few additional forecasts are needed involving noncash transactions and transfers between balance sheet accounts in order to prepare a complete forecasted balance sheet. It is doubtful whether much is gained by preparing a budgeted balance sheet for the end of each month of the budget period, but such a statement for the end of the period is definitely helpful in presenting the net effect on the company's financial condition of the forecasted transactions for the period.

**FORECASTED PROFIT AND LOSS STATEMENT**—This statement is prepared to present the net effect of the forecasted transactions for the period on the net earnings of the business. The monthly forecasted profit and loss statements are usually prepared in addition to a forecasted profit and loss statement for the budget period as a whole. Monthly budgets provide a basis for judging each month's contribution to the net profit goal set for the budget period, and provide a means for comparing actual with budgeted results by totals of the various activities. More detailed comparisons can be made from individual departmental budgets supporting the forecasted profit and loss statement.

**SUMMARY STATEMENT PROCEDURE**—The most common methods used in bringing together data from several budgets is to prepare statements in the usual form and then pick from the individual budgets the figures needed in the development of the statements. An organized procedure for the construction of summary statements facilitates their preparation and helps to avoid omission of items. Howell has suggested (N.A.C.A. Year Book, 1933) use of formal entries and work sheets for this purpose (Fig. 27). The form for recording the formal entries provides, in addition to the usual adjustment columns where accounts to be debited and credited are indicated debit and credit money columns for each month of the budget period. In moving from one detail budget to another, forecasted transactions for the period are journalized the same as actual transactions. The journal entries are then posted to the work sheet (Fig. 27), the postings from one entry being given the same identifying number or, in this case, letter. Thus for



## WORK SHEET

First Half

	TRIAL BALANCE 1/1/—	OTHER ACCOUNTS January to June *	
		Dr	Cr
Cash	65 000		
January		35 674 B	35 328 N
February		30 015 B	31 450 N
March		34 351 B	37 214 N
April		37 035 B	34 406 N
May		34 454 B	29 534 N
June		30 730 B	27 802 N
Accounts Receivable	65 854		
January		30 778 A	35 450 B
February		36 003 A	37 001 B
March		38 864 A	34 684 B
April		30 308 A	37 453 B
May		38 416 A	35 100 B
June		38 687 A	37 150 B
Inventory Raw Material	30 000	34 709 F	34 702 G
Inventory Finished Goods	198 950	122 345 H	187 705 L
		18 460 K	
		64 <sup>9</sup> J	180 M
Inventory Variance			
Real Estate	180 000		
Machinery	180 000		
Furniture and Equipment	78 700		
Prepaid Insurance	108	262 D	
Standard Cost of Sales Our Manufacture		180 845	
Variance from Standard Cost		180	
Cost of Sales Purchased		26 950	
Sales Discounts		2 172	
Bad Debts		6 820	
Sales Expense North		7 285	
South		10 505	
West		4 650	
Administrative Expense		25 325	
Advertising		4 200	
Fixed Operating Expense		300	
Manufacturing Expense		10 854 D	10 854 G
Labor		27 431 F	27 431 O
Labor Variance		27 431 G	27 431 H
Material Variance		34 702 G	34 702 H
Expense Variance		10 854 G	10 912 H
Total Debits	608 532		642 J
Sundry Accrued Payables	14 117	138 E	60 742 D
		101 197 N	112 132 F
			18 400 K
Reserve for Taxes	7 435		300 E
Reserve for Bad Debts			6 820 C
Reserve for Depreciation	45 000		2 787 D
Sales Our Manufacture			107 000
Sales Purchased Goods			30 300
Discount on Purchases			309
Capital	275 000		
Profit and Loss			
Transferred to Surplus	327 080		
Total Credits	608 682	1 270 625	1 270 625

\* Where there are many cash transactions use horizontal columns to facilitate

FIG 27 Work

FOR BUDGET  
of 19—

PROFIT AND LOSS						BALANCE SHEET 6/30/—
January	February	March	April	May	June	
						118 637
						76 977
						30 000 152 000
						462 100 000 100 000 78 700 420
23 205 L	24 713 L	27 504 L	25 735 L	27 133 L	27 595 L	
	15 M	28 M	38 M	46 M	55 M	
4 701 L	4 135 L	4 393 L	4 297 L	4 541 L	4 503 L	
376 B	386 B	333 B	368 B	45 B	304 B	
1 105 G	1 050 G	1 106 G	1 091 G	1 152 G	1 105 G	
1 232 D	1 160 D	1 200 D	1 172 D	1 232 D	1 249 D	
1 900 D	1 650 D	1 850 D	1 735 D	1 830 D	1 840 D	
800 D	700 D	775 D	735 D	790 D	790 D	
4 236 D	4 231 D	4 246 D	4 285 D	4 236 D	4 241 D	
856 D	634 D	881 D	556 D	647 D	626 D	
61 D	68 D	6 D	97 D	68 D		
63 632	39 742	42 592	40 107	42 060	42 429	656 746
						14 117
						7 325 6 520 47 757
34 475 A	30 335 A	33 687 A	31 520 A	33 294 A	33 636 A	
5 303 A	4 065 A	5 181 A	4 848 A	5 122 A	5 181 A	
140 N	60 N		140 N	20 N		
8 705 L	3 870 L	3 714 L	3 599 L		3 562 L	275 000
				3 624 J		305 197
43 032	35 719	42 589	40 107	42 060	42 429	656 746

preparation of Cash Receipts and Disbursements statement  
Sheet for Budget

For the

	Total	Cash	Accounts Receivable	Notes Receivable
--	-------	------	---------------------	------------------

Credits estimated during the year 19—

Accounts Payable (Schedule O)	354 000 00	354 000 00		
Sales Returns and Allowances (Schedule B)	6 770 00		6 770 00	
Sales Discount (Schedule 8 F)	1 675 00		1 675 00	
Cash (Schedule Q)	300 500 00		355 000 00	5 500 00
Notes Receivable (Schedule P)	5 000 00		5 000 00	
Worthless Accounts Write Off (contra)	4 720 00		4 720 00	
Notes Receivable Discounted Contingency (contra)	2 000 00			2 000 00
Direct Materials Used (Schedule 12 H)	80 805 36			
Indirect Materials and Supplies Used (Schedule 14 J)	14 374 00			
Cost of Production (Schedule K)	279 600 04			
Cost of Goods Sold (Schedule M)	280 513 76			
Patent Write Off (Schedule 14 J)	200 00			
Charges to Expense (Schedule 6 D)	1 200 00			
Charges to Expense (Schedule 7 E)	1 100 00			
Charges to Expense (Schedule 8 F)	600 00			
Charges to Expense (Schedule 14 J)	2 400 00			
Debit Balance estimated on December 31, 19—	1 300 604 76	354 000 00	373 165 00	7 500 00
	400 603 10	15 744 00	43 886 10	

\* Schedules not shown

FIG 28 Work Sheet of Estimated

January, Cash is debited while Accounts Receivable and Sales Discounts are credited as shown by the letter "B" Howell points out

The method shown, involving the use of journal entries and the work sheet, makes the adjustment of the budget a simple matter and free from errors and omissions, due to not following through every transaction. Many times a variation occurs and they say "That affects our sales" and they will change the sales budget but forget all the other things it affects. If you follow through with a set of entries, you cannot miss these things.

Another method of accounting for data for the summary budgets is presented by Van Sickle (Cost Accounting). The work sheet shown

Year 10 -

Inventories			Patents	Fuel Inven- tory	Prepaid Expenses		Office Supplies Inven- tory	Other Fixed Assets
Stores	Work in Process	Finished Goods			Prepaid Insur- ance	Bond Discount Unamor- tized		
44 000 01	1 801 51	29 317 42	2 300 00	188 33	856 00	4 500 00	482 45	314 750 00
90 000 00	279 866 64	3 183 85 279 866 64		1 200 00	1 180 00		2 400 00	
134 000 01	281 468 10	312 307 91	9 800 00	1 333 33	2 636 00	4 500 00	3 862 45	314 750 00
80 805 36 18 374 00	279 866 64	280 513 76	900 00		90 00 90 00	500 00	1 200 00 1 100 00	
98 979 30	279 866 64	280 513 76	200 00	1 200 00	1 200 00	500 00	2 300 00	
86 020 65	1 801 51	31 854 15	2 000 00	133 33	656 00	4 000 00	552 45	314 750 00

## Balances in Asset Accounts

(Fig. 28) summarizes the effect of forecasted transactions on the asset items of the balance sheet

The following illustration was worked out by Bernard and represents budgetary procedure of a large manufacturer of hardware. The illustration is complete, from the initial sales forecast to the final statements (NACA Bulletin, vol 17). For each of the many individual statements it shows the source of information that is, the basis on which the forecast is made, and shows further the ultimate disposition of the estimates either in the balance sheet forecast or profit and loss forecast, or in some other forecast subsidiary to these two

## Statement No 1 Sales Forecast

BASIS OF INFORMATION	Statement No 1 Sales Forecast		
	JANUARY	FEBRUARY	MARCH
Past performance interpreted in the light of future expectations	Anticipated Sales	Anticipated Sales	Anticipated Sales
	\$300 000	\$250 000	\$275 000
			Accounts Receivable
			Profit and Loss

## Statement No 2 Cost of Sales Forecast

Sales forecast	Net Sales	\$290 000	\$250 000	\$275 000
	Direct Labor 18% of Sales	\$ 46 200	\$ 45 000	\$ 49 500
	Direct Materials 22 1/2% of Sales	58 500	56 250	61 875
	Indirect Factory Labor			
	Fixed Executives, \$2 000 per month	2 000	2 000	2 000
	Foremen 1 000 per week	4 000	4 000	4 000
	Variable 63% of Direct Labor	29 000	27 500	30 700
Cost of anticipated sales based on inventory value or current costs	Factory Supplies and Expense			
	Fixed Taxes	5 000	5 000	5 000
	Insurance	500	500	500
	Light Heat and Power	7 500	7 500	7 500
	Variable 28% of Direct Labor	12 200	11 700	12 800
	Depreciation charged to Cost of Sales	8 500	8 500	8 500
	Cost of Sales	\$174 500	\$168 450	\$183 975
				Inventory
				Profit and Loss

## Statement No 3 Factory Production Forecast

Production coordinated with the anticipated sales of the budget period The elements of cost to sales are based on inventory value or current costs	Direct Labor \$11 000 per week	\$ 43 400	\$ 44 000	\$ 43 400
	Direct Materials 125% of Direct Labor	60 500	55 000	60 500
	Indirect Factory Labor			
	Fixed Executives \$2 000 per month	2 000	2 000	2 000
	Foremen 1 000 per week	4 000	4 000	4 000
	Variable 63% of Direct Labor	30 000	27 300	30 000
	Factory Supplies and Expense			
	Fixed Taxes	5 000	5 000	5 000
	Insurance	500	500	500
	Light Heat and Power	7 500	7 500	7 500
	Variable 28% of Direct Labor	12 600	11 400	13 000
	Depreciation	8 600	8 600	8 600
	Cost of Production	\$179 500	\$165 300	\$179 500
				Accounts Payable
				Accounts Payable
				Accounts Payable
				Accounts Payable
				Inventory

## Statement No 4 Selling Expense Forecast

BASIS OF INFORMATION	CARRIED TO FORECAST OF		
	JANUARY	FEBRUARY	MARCH
Estimated on basis of most recent experience and after giving due consideration to possible changes. The variability in expenses was determined to be 2% of sales and fixed expenses \$12,300 per month. The payroll which will not vary with sales comprises: Paid weekly \$3,478 Paid monthly 5,000	\$ 17,500	\$ 17,500	\$ 17,800
Plant Ledger and Reserve for Depreciation forecast	20,300	18,900	20,300
	<u>1,500</u>	<u>1,500</u>	<u>1,500</u>
	<u>\$ 39,300</u>	<u>\$ 37,900</u>	<u>\$ 39,600</u>
			Accounts Payable
			Accrued Payroll
			Reserve for Depreciation
			Profit and Loss

## Statement No 5 Administrative Expenses Forecast

Estimated on basis of most recent experience and after giving due consideration to possible changes. The variability in expense was determined to be 2% of sales and fixed expenses \$3,600 per month. The payroll which will not vary with sales comprises: Paid weekly \$3,478 Paid monthly 5,000	\$ 8,900	\$ 8,600	\$ 9,100
Plant Ledger and Reserve for Depreciation forecast	20,300	18,900	20,300
	<u>2,000</u>	<u>2,000</u>	<u>2,000</u>
	<u>\$ 31,100</u>	<u>\$ 29,500</u>	<u>\$ 31,400</u>
			Accounts Payable
			Accrued Payroll
			Reserve for Depreciation
			Profit and Loss



## Statement No 7 (Continued) Reserve for Bad Debts Forecast

BASIS OF INFORMATION	CARRIED TO FORECAST OF		
	JANUARY	FEBRUARY	MARCH
Based on experience			
Accounts and Notes Receivable			
Balance beginning of month	\$ 50 000	\$ 50 000	\$ 50 000
Credits			
Provision for possible loss (1%)		2 750	2 750
Charges	2 600	2 300	2 750
	\$ 52 600	\$ 52 300	\$ 52 750
Accounts Written Off	2 600	2 300	2 750
Balance end of month	\$ 50 000	\$ 50 000	\$ 50 000
			Other Deductions
			Balance Sheet

## Statement No 8 Miscellaneous Accounts Receivable Forecast

Based current charges			
Based current charges			
Term of lease			
Charges paid monthly			
Term of lease			
Balance beginning of month	\$ 1 000	\$ 1 000	\$ 1 000
Anticipated Charges for			
Gasoline and Oil Sales	1 000	1 000	1 000
Garage Rentals to Employees	200	200	200
Rent to Tenants	1 000	1 000	1 000
	\$ 3 200	\$ 3 200	\$ 3 200
Anticipated Credits for			
Cash Received from	\$1 200		
Employees	1 000		
Tenants			
Balance end of month	2 200	2 200	2 200
	\$ 1 000	\$ 1 000	\$ 1 000
			Cash
			Balance Sheet



## Statement No 9 Inventory Forecast

BASIS OF INFORMATION	JANUARY FEBRUARY MARCH			CARRIED TO FORECAST OF
Factory Production forecast				
	Balance beginning of month	\$1 000 000	\$1 000 000	\$1 001 830
	Factory Production	179 500	165 300	179 500
		\$1 179 500	\$1 170 300	\$1 181 330
Cost of Sales forecast				
	Cost of Sales	174 500	168 450	183 975
	Balance end of month	\$1 005 000	\$1 001 850	\$ 998 375
				Balance Sheet

## Statement No 10 Deferred Charges Forecast

Balance beginning of month	\$ 8 000	\$ 2 000	\$ 1 000	
Interest	\$ 19 000	\$ 23 700	\$ 28 550	
Insurance etc	\$ 23 000	\$ 24 700	\$ 29 550	
Anticipated Charges				Accounts Payable
Interest	\$ —	\$ —	\$ 6 000	
Insurance etc	\$ 10 700	\$ 17 850	\$ 15 000	
Anticipated Credits				Other Deductions
Interest	1 000	1 000	1 000	
Insurance etc.	12 000	12 000	12 000	Distributed to the various expenses
Balance end of month	\$ 2 000	\$ 1 000	\$ 6 000	
Interest	23 700	28 550	31 550	
Insurance etc	\$ 24 700	\$ 29 550	\$ 37 550	Balance Sheet
(a) Increase in Insurance etc	\$ 3 700	\$ 5 850	\$ 3 000	Accounts Payable

(a) Only the increase or decrease in insurance etc is carried to the Accounts Payable forecast because the anticipated expenses in the Accounts Payable forecast of anticipated liabilities to be incurred are the actual expenses of the month and include book transfers for insurance etc. Therefore since the insurance etc which is absorbed in costs is included in the Accounts Payable forecast the amount not yet included must be similarly included.

## Statement No 11 Fixed Assets Forecast

BASIS OF INFORMATION	Statement No 11 Fixed Assets Forecast		
	JANUARY	FEBRUARY	MARCH
Balance beginning of month	\$3 000 000	\$2 004 000	\$2 008 000
Anticipated Additions			
Labor	\$ 2 000	\$ 2 000	\$ 2 000
Materials and Supplies	2 000	2 000	2 000
Anticipated Sales and other dispositions	4 000	4 000	4 000
Balance end of month	\$2 004 000	\$9 006 000	\$3 012 000
Balance Sheet	\$2 004 000	\$3 008 000	\$3 012 000

## Statement No 11 Reserve for Depreciation Forecast

Balance beginning of month	\$ 500 000	\$ 512 500	\$ 525 000
Credits Provision for depreciation charged to			
Cost of Sales	\$ 8 000		
Administrative	2 000		
Selling	1 500		
Idle Plant	400		
Charges Accumulated provision for depreciation on fixed assets disposed of	12 500	12 500	12 500
Balance end of month	\$ 512 500	\$ 625 000	\$ 637 500
Balance Sheet	\$ 512 500	\$ 625 000	\$ 637 500

## Statement No 12 Notes Payable Forecast

Balance beginning of month	\$ 100 000	\$ 100 000	\$ 100 000
Additional bank borrowings			
Bank borrowings paid	100 000	100 000	100 000
Balance end of month	\$ 100 000	\$ 100 000	\$ 100 000
Balance Sheet	\$ 100 000	\$ 100 000	\$ 100 000

## Statement No 13 Accounts Payable Forecast

BASIS OF INFORMATION	CUMULATIVE TO FORECAST OF			
	JANUARY	FEBRUARY	MARCH	
	\$ 70 000	\$ 90 000	\$ 88 000	
Balance beginning of month				
Anticipated Liabilities Incurred				
Raw Materials	\$ 60 500	\$ 55 000	\$ 60 500	
Factory Supplies and Expense	25 600	24 400	25 600	
Fixed Assets	2 000	2 000	2 000	
Selling Expenses	17 500	17 500	17 500	
Administrative Expenses	8 800	8 600	9 100	
Accounts and Notes Receivable	2 000	1 900	2 100	
Miscellaneous Accounts Receivable				
Idle Plant	1 000	1 000	1 000	
Deferred Charges	1 000	1 000	1 000	
Deferred Charges	3 700	5 850	6 000	
	\$123 100	\$117 050	\$128 100	
Deduct				
City and State Taxes	\$ 7 400	\$ 7 500	\$ 7 500	
Discount on Purchases	600	550	600	Other Income
	\$ 8 100	\$ 8 050	\$ 8 100	
	\$114 000	\$109 000	\$120 000	
	\$184 000	\$199 000	\$208 000	
	94 000	111 000	127 000	Cash
	\$ 90 000	\$ 88 000	\$ 81 000	Balance Sheet
Accounts Payable Disbursements				
Balance end of month				

Taxes are included in above expense & hence this liability is transferred to the Tax a/c  
Based on experience

Accounts Payable Disbursements

## Statement No 14 Accounts Payable Disbursements Forecast

BASIS OF INFORMATION		JANUARY	FEBRUARY	MARCH	CARRIED TO FORECAST OF
Accounts Payable	Balance of Accounts Payable at beginning of month	\$ 70 000	\$ 90 000	\$ 88 000	
	Eliminate items not Currently Payable				
	Professional Services	\$ 4 500	\$ 9 000	\$ 1 500	
	Capital Stock Tax	3 000	3 000	3 000	
		\$ 7 500	\$ 6 000	\$ 4 500	
	Accounts Currently Payable	\$ 62 500	\$ 82 000	\$ 83 500	
	Also				
Policy of paying all bills on due date and taking advantage of cash discounts	50% of materials purchased during the month	30 250	27 500	29 250	
Note Payable Register	Interest on Notes Payable	—	—	5 000	
Based on experience	Professional Services	—	—	4 000	
Insurance Register	Insurance due during the month of renewal	1 250	1 500	2 250	
Subscription due date	Community Chest	—	—	1 000	
		\$ 94 000	\$111 000	\$127 000	Accounts Payable

## Statement No 15 Accrued Payroll Forecast

BASIS OF INFORMATION	JANUARY FEBRUARY MARCH			CARRIED TO FORECAST OF
Balance beginning of month	\$ 10 000	\$ 24 400	\$ 23 300	
Anticipated Earned Payroll				
Direct Labor	\$ 48 400	\$ 44 000	\$ 48 400	
Indirect Factory Labor	36 400	33 300	36 400	
Selling Salaries	20 300	18 900	20 300	
Administrative Salaries	20 300	18 900	20 300	
Fixed Assets	2 000	2 000	2 000	
	\$127 400	\$117 100	\$127 400	
Estimated on basis of paying payroll in accordance with departmental schedule	\$137 400	\$141 500	\$150 700	Cash
Balance end of month	\$ 24 400	\$ 23 300	\$ 33 300	Balance Sheet

## Statement No 16 Accrued City and State Taxes Forecast

Balance beginning of month	\$ 59 000	\$ 57 500	\$ 30 000	Various expense accounts
Monthly Accrual	7 400	7 500	7 500	(See accounts payable)
Payments	\$57 500	\$ 65 000	\$ 37 500	Cash
Balance end of month	—	35 000	500	Balance Sheet

## Statement No 17 Federal Tax on Income Forecast (Prior Year)

Balance beginning of month	\$ 10 000	\$ 10 000	\$ 10 000	Cash
Payments	—	—	2 500	Balance Sheet
Balance end of month	\$ 10 000	\$ 10 000	\$ 7 500	

## Statement No 18 Federal Tax on Income Forecast (Current Year)

Balance beginning of month	\$ —	\$ 1 141	\$ 2 214	Balance Sheet
Provision on current year's income	1 141	1 073	1 587	
	\$ 1 141	\$ 2 214	\$ 4 101	

## Statement No 19 Other Income Forecast

BASIS OF INFORMATION	CARRIED TO FORECAST OF		
	JANUARY	FEBRUARY	MARCH
Accounts and Notes Receivable	\$ 100	\$ 100	\$ 100
Miscellaneous Accounts Receivable	1 000	1 000	1 000
Garage Rentals to Employees	200	200	200
Discount on Purchases	600	550	600
Accounts Payable	<u>\$1 900</u>	<u>\$1 850</u>	<u>\$1 900</u>
			Profit and Loss

## Statement No 20 Other Deductions Forecast

Accounts and Notes Receivable	\$3 700	\$3 500	\$4 050
Reserve for Bad Debts	2 600	2 500	2 750
Deferred Charges	1 000	1 000	1 000
Idle Plant	1 400	1 400	1 400
	<u>\$8 700</u>	<u>\$8 400</u>	<u>\$9 200</u>
			Profit and Loss

## Statement No 21 Idle Plant Forecast

Allocating to Idle Plant expenses determined to be chargeable thereto	Taxes	Insurance	Light	Heat	and Power etc	
Plant Ledger and Reserve for Depreciation forecast						
			400			400
			<u>\$1 400</u>	<u>\$1 400</u>	<u>\$1 000</u>	<u>\$1 400</u>
						Other Deductions forecast

## Statement No 22 Balance Sheet Forecast

BASIS OF INFORMATION		DECEMBER 31 ACTUAL	JANUARY 31	FEBRUARY 29	MARCH 31
FORECAST OF					
ASSETS					
CURRENT ASSETS					
Cash		\$ 287 000	\$ 312 200	\$ 284 200	\$ 309 100
Accounts and Notes Receivable		450 000	450 800	457 800	468 000
Miscellaneous Accounts Receivable		1 000	1 000	1 000	1 000
Inventory		1 000 000	1 000 000	1 001 800	998 375
		\$1 718 000	\$1 764 000	\$1 744 800	\$1 770 475
Deferred Charges		22 000	24 700	20 200	37 550
Fixed Assets		1 500 000	1 491 500	1 483 000	1 474 500
		\$3 240 000	\$3 290 200	\$3 267 400	\$3 285 325
LIABILITIES					
CURRENT LIABILITIES					
Notes Payable		\$ 100 000	\$ 100 000	\$ 100 000	\$ 100 000
Accounts Payable		70 000	90 000	88 000	81 000
Payroll Accrued		10 000	24 400	23 300	33 200
City and State Taxes		50 000	57 200	50 000	37 000
Federal Tax on Income		10 000	10 000	10 000	7 500
Prior year		—	1 141	2 214	4 101
Current year		\$ 240 000	\$ 253 041	\$ 253 514	\$ 262 801
Net Worth					
Capital Stock					
6% Cumulative Preferred		\$1 000 000	\$1 000 000	\$1 000 000	\$1 000 000
and outstanding 10 000 shares with a par value of \$100 each.					
Common Authorized		1 000 000	1 000 000	1 000 000	1 000 000
issued and outstanding 40 000 shares with a par value of \$25 each		1 000 000	1 007 129	1 013 895	1 025 724
Surplus		\$3 000 000	\$3 097 150	\$3 013 886	\$3 035 724
Surplus forecast		\$3 240 000	\$3 290 200	\$3 267 400	\$3 285 325

Statement No 23 Profit and Loss Forecast

Basis of Information

Forecast of

Sales  
Cost of Sales  
Selling Expenses  
Administrative Expenses

Net Sales  
Cost of Sales  
Gross Profit on Sales  
Selling Expenses  
Administrative Expenses  
Profit from Operations  
Other Income

Other Deductions

Net Profit before Federal Tax on  
Income  
Federal Tax on Income (13%)  
Net Profit

JANUARY FEBRUARY MARCH CARRIED TO FORECAST OF

\$ 200 000	\$ 250 000	\$ 275 000
174 500	168 450	152 975
\$ 25 500	\$ 81 550	\$ 92 025
\$ 20 300	\$ 27 700	\$ 30 000
\$1 100	20 500	21 400
\$ 70 400	\$ 67 200	\$ 71 000
\$ 15 100	\$ 14 350	\$ 21 025
1 900	1 850	1 900
\$ 17 000	\$ 16 200	\$ 22 925
\$ 700	\$ 600	\$ 9 200
\$ 8 300	\$ 7 500	\$ 12 725
1 141	1 073	1 887
\$ 7 159	\$ 6 727	\$ 11 838

Federal Tax on Income  
current year  
Surplus

Statement No 24 Surplus Forecast

Forecast of  
Profit and Loss

Balance beginning of month  
Net Profit for the month  
Balance end of month

\$1 000 000	\$1 007 129	\$1 013 586
7 159	6 727	11 838
\$1 007 159	\$1 013 856	\$1 025 724



## TUBE TINNING DEPARTMENT No 14

October 19—

Description	CURRENT MONTH				YEAR TO DATE			
	Actual	Standard	Over	Under	Actual	Standard	Over	Under
<b>LABOR</b>								
Set-Up	\$ 45 20	\$ 40 07	\$ 4 23	\$ 10 10	\$ 375 22	\$ 389 12		\$ 13 90
Operating	97 37	96 47			10 419 76	11 005 72		\$ 585 96
Idle Time								
Servicing	4 96	9 20		4 24	51 26	49 10	\$ 2 26	
Miscellaneous	3 22	6 54		3 32	37 19	22 64	14 55	
Total	\$1 028 75	\$1 042 18		\$ 13 43	\$10 833 53	\$11 466 95		\$ 533 05
<b>REPAIRS</b>								
Tinuing Machines	\$ 47 60	\$ 85 22		\$ 37 62	\$ 501 37	\$ 504 10		\$ 2 73
Servicing Machines	2 13	10 14		8 01	37 12	31 67		4 45
Miscellaneous	67 36	70 19		2 83	701 13	752 17		51 04
Total	\$ 117 09	\$ 165 55		\$ 48 46	\$ 1 229 02	\$ 1 257 94		\$ 28 92
<b>SUPPLIES</b>								
Electricity	\$ 20 05	\$ 18 14	\$ 1 91		\$ 251 13	\$ 263 14		\$ 47 01
Gas	53 75	69 12		11 39	481 64	501 17		9 53
Solder	1 927 64	2 214 70		287 06	20 417 36	24 379 10		3 967 80
Total	\$2 001 42	\$2 297 96		\$296 54	\$21 160 13	\$25 174 47		\$4 014 34
TOTAL VARIABLE BURDEN	\$3 147 26	\$3 505 69		\$358 43	\$53 273 28	\$57 928 99		\$4 656 71
<b>FIXED CHARGES</b>								
Depreciation	\$ 54 27	\$ 54 27			\$ 551 10	\$ 551 10		
Taxes	16 36	10 26			108 74	108 74		
Insurance	2 96	2 96			22 16	22 16		
Salaries	85 22	85 22			750 13	765 13		
Total Fixed	\$ 152 81	\$ 152 81			\$ 1 477 13	\$ 1 477 13		
General Factory	\$1 019 76	\$1 002 10	\$17 66		\$10 526 71	\$ 9 412 16	\$1 114 55	
Total Burden	4 319 83	4 660 40		340 77	45 277 12	48 818 28		\$3 541 16
Credits	5 210 64	5 210 64			60 417 38	60 417 38		\$3 541 16
Balance	\$ 890 81	\$ 550 04		\$340 77	\$ 5 140 26	\$ 1 599 10		

FIG 29 Monthly Burden Statement

Cr

**BUDGET REPORTS**—Figs 29 to 32 illustrate the essentials to be considered in reporting on budget performance. These essentials are:

- 1 Every report should compare actual results with budget or standard allowances.
- 2 Where cost varies with volume or rate of activity, the budget allowances should be of the flexible type.
- 3 Reports should be limited to those activities over which the executive receiving the report has control.
- 4 The period of time covered by the report is determined by the duties of the executive receiving it. Foremen need frequent reports because they exercise day to day control over expenditures. Department heads are more interested in supervision and need less frequent reports. Top executives are concerned primarily with policies and need reports covering still longer periods of time.
- 5 Reports for current period should be accompanied by cumulative figures for a longer period. Many items of cost show large variations over short periods but these variations tend to iron out over longer periods. Cumulative figures for year to date as illustrated in Fig 29, taken from Peden (N.A.C.A. Bulletin vol 18) help considerably in interpreting the variations for a shorter period.
- 6 Reports should usually show favorable and unfavorable variances from the budget. This helps to focus attention on variances and utilizes the principle of exceptions, by directing attention to only those items where significant variances have occurred. This plan is used in Fig 29 also in Fig 30 taken from Simmons (N.A.C.A. Bulletin vol 16). In Fig 32 from Willis (N.A.C.A. Bulletin vol 17), ratios rather than dollar variances are shown.

BANKING DEPARTMENT				
Week Ending March 10, 19—				
	Budget	Actual	Increase	Decrease
Standard Direct Labor	<u>\$1 000</u>	<u>\$1 800</u>	<u>\$800</u>	
Indirect Labor				
Supervision	\$ 100	\$ 105	\$ 5	
Factory Clerical	50	28		\$22
Inspection	75	78	3	
Die Setting	200	320	120	
Floormen	50	55	5	
Weighers	40	38		2
Sweepers	20	19		1
Total	<u>\$ 615</u>	<u>\$ 643</u>	<u>\$ 28</u>	<u>\$5</u>
Repairs to Tools	100	110	10	
Repairs to Machinery	25	24		1
Manufacturing Supplies	15	18	3	
Light Heat and Power	50	55	5	
Spoilage	50	32		18
Total Expense	<u>\$ 885</u>	<u>\$ 882</u>	<u>\$ 3</u>	<u>\$3</u>
Net over budget			\$ 47	
Ratio of increase in production over budget			20%	
Ratio of increase in expense over budget			5.6%	

FIG 30 Departmental Expense Report

DEPT	NO 1 MACHINE	ACTUAL	\$ PER	\$ Yr	EXPLANATION OF LARGE VARIATIONS	MILL	STR	THRU	P	DR	CD	NAVY
PERIOD	BUDGET											
1	1 341 00	1 012 58	70 5		WIKES AND JACKETS IMPARTED AT \$65 NOT USED							
2	1 209 00	1 210 07	100 1	87 2	REPAIR LABOR + MATERIAL - STOP LABOR MISC LABOR BONES + COLOR LABOR WEIR BUDGET 406							
3	748 00	1 033 96	128 2	56 8	DEGRADED 26 7 HRS OVER ST BOUND - BUDGET LOSS 126 DIRECT LABOR MISC LABOR BONES							
4	1 383 00	1 412 86	102 2	99 8	REPAIR LABOR BLUETLY OVER BUDGET MUCH CLOTHING OVER BUDGET (2 MOY FELTS)							
5	1 089 00	1 033 36	101 3	100 0								
6	1 497 00	1 429 03	96 5	99 1								
7	1 461 00	1 418 14	97 1	90 8								
8	969 00	1 066 56	110 0	99 2								
9	632 00	815 46	129 0	101 7	MM EFFICIENCY SHOWS A GRM MACHINE CLOTHING ABOVE BUDGET							
10	10 329 00	10 202 32	82 5	100 5	RE AIR TERNAL OVER - REP INS TO T CHAPTER (\$105)							
11	697 00	575 36	82 5	100 5	MACHINE CLOTHING BELOW BUDGET							
12	11 020 00	11 077 68	82 5	100 5								
13	1 406 00	1 157 81	80 0	98 5	MACHINE CLOTHING BELOW BUDGET ALSO REP IN MATERIAL + LABOR ARE BUDGETS							
14	12 432 00	12 245 29	80 0	98 5								
15	1 100 00	1 205 74	102 1	99 4								
16	13 592 00	13 511 03	102 1	99 4								
17	1 649 00	1 569 66	95 2	98 9								
18	15 241 00	15 080 69	95 2	98 9								

Fig 31 Comparison of Actual and Budgeted Expenses

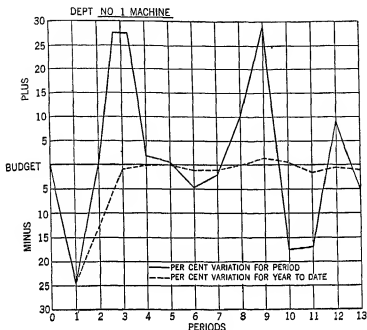


FIG 32 Graphic Comparison of Actual and Budgeted Expenses  
(based on Fig 31)

- 7 Circling or some other method of calling attention to important variances is often helpful
- 8 In many cases particularly in detailed reports to foremen and minor executives the reasons for or explanations of variances are helpful This is illustrated in Fig 31 also from Willis (cited above) It is ordinarily not possible to observe this practice in reports to top executives, which usually are summaries combining the details shown in several reports
- 9 Reports should be prepared as promptly as possible If reports are to be an aid to control they must be issued as soon as possible after the close of the period which they cover while the events reported are still in the minds of the foreman or department head
- 10 Where executives prefer, formal reports should be replaced or supplemented by charts, graphs and visual reports These are particularly useful in reporting trends or showing relationships Fig 32 illustrates how a trend chart showing data for both the current period and the period to date can be used to accompany a tabular report



## SECTION 24

### TRADE ASSOCIATIONS AND UNIFORM SYSTEMS

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## SECTION 24

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# TRADE ASSOCIATIONS AND UNIFORM SYSTEMS

### Uniform Cost Accounting Activities of Trade Associations

**NEED FOR UNIFORM METHODS OF COSTING**—The term "uniform cost accounting" covers an extension of the principles practices, and procedures of plant cost accounting on an industry-wide basis through the medium of a trade association or other central agency. The idea of uniformity in cost accounting rests on the established fact that all concerns in an industry compete as to products and prices, and that it is essential to their individual welfare that each properly understand and recognize its costs. Otherwise, products may in ignorance be priced at too low a figure and force losses upon all members of the industry. The individual plant thus recognizes that its own welfare is definitely linked to intelligent operation of other members of the industry.

Through the trade association a program can be established to educate members as to the desirability of uniform cost accounting and its underlying principles. Where it seems advisable, uniform costing programs or systems can be devised and introduced. As a further step, the financial results obtained from the uniform policies or methods can then be utilized as a means for making comparisons, developing standards, and in other ways assisting individual members to eliminate waste and inefficiency.

**OBJECTIVES OF UNIFORM COSTING**—The advantages of uniform costing or accounting represent the justification for carrying on these activities by trade associations. The United States Chamber of Commerce has summarized the advantages to be obtained from uniform accounting as follows:

- 1 Provides the "one best way" known to the industry to figure costs thereby eliminating expensive experimentation by the members of the industry individually and independently.
- 2 Results in a better informed competition within the industry.
- 3 Enables the industry to place significant cost data before regulatory bodies.
- 4 Inspires confidence in the public that selling prices are established by producers who have full knowledge of the costs of the articles offered for sale.
- 5 Tends to convince the manufacturer who otherwise would fail to see the advantages of good cost accounting of the desirability of adopting the methods which his competitors are successfully using.



- 6 Reveals lines of individual products which have been marketed on an unprofitable basis
- 7 Provides all of the valuable features of sound cost accounting generally among which are the following
  - a Shows the danger line below which goods cannot be sold at a profit thus serving as an insurer of profits
  - b Acts as a guide to the value efficiency and waste of workers machines methods operations and entire plants
  - c Provides a reliable guide and basis for estimating the cost of prospective business
  - d furnishes current reports for comparing major cost items with standards which are predetermined and thereby measures and increases operating efficiency

Another insight into the objectives of uniform cost activities is provided through the results of a survey made by the Policyholders' Service Bureau of the Metropolitan Life Insurance Company. This Bureau summarized the reasons for uniform cost activities as follows

- 1 To improve competitive conditions by providing basic cost information on which to develop price policies within an industry
- 2 To increase operating efficiency through a better knowledge and a more complete use of costs
- 3 To promote stability within the industry
- 4 To improve public relations through concentrated educational effort
- 5 To discourage unnecessary plant expansion within the industry

The objectives of uniform costing to a manufacturer have also been well stated in the Cost and Accounting Manual of the National Container Association

- 1 He must know how to price his merchandise based on his actual or anticipated costs with due regard to the character and extent of his prospective market
- 2 He must check his actual performance against his estimated or anticipated performance in order that his profits or losses may be explained his costs kept under control and his performance bettered from year to year

The translation of costs into prices is a function of management which is of fundamental importance to the company to the industry, and to the consuming public

Prices below cost are frequently brought about by nothing more or less than unintelligent or ill devised methods of price making. Where the products of an industry are sold on the basis of price estimates as in the container industry it is entirely possible for two manufacturers with identical equipment and approximately equal costs to translate those costs into prices by methods so entirely different that the resulting market level will bankrupt both of them. One manufacturer, for example, may establish a relatively low price on small boxes while the other may establish a low price on large boxes. If each could get his normal volume on both large and small boxes at his own price all would be well but the low price of one drives down the high price of the other, and both end up with nothing but low price business on their heels.

To the extent that activities are concerned with education in cost finding, the objectives are to make the operations of an individual company more intelligent. Unless this is done, a company may, through its ignorance of costs, quote prices which are a disturbing factor in the industry and may in general promote competitive chaos. Even where

this particular situation is not involved, more scientific development of accounting methods and analysis promotes the general efficiency of all members of the group, and enables the industry to compete more effectively with other industrial groups

**NATURE AND SCOPE OF UNIFORM COST PLANS**—The term "uniform cost plan" covers a wide range of activities varying from minor association activities which bear directly or indirectly on cost matters to the completely developed programs with formal cost accounting systems reports, analyses, etc. Some of the activities in this general field which may be carried on partially or completely are as follows

- 1 Papers speeches or discussions of matters pertaining to costs in trade publications or at conventions
- 2 Publication of educational literature as to problems and objectives of cost finding
- 3 Studies of particular costing problems in the industry to develop sound principles
- 4 Activities of a counseling nature relative to establishment or operation of cost accounting systems but no effort to design a uniform system
- 5 Development of estimating formulas or short cut methods of establishing bases for pricing
- 6 Development and promotion of a uniform cost program
  - a Principles of costing only with no attempt to prescribe procedures or records
  - b Definition and identification of cost factors to be recognized and used
  - c Charts of accounts with definition or explanation of accounts
  - d Design of complete programs of cost accounting with forms, procedures etc
  - e Actual installation and in some cases supervision of accounting operations
- 7 Cost studies to determine average or representative cost of products functions or activities for general information of members
- 8 Regular collection and dissemination of cost data under some kind of reporting plan
- 9 Complete analyses of cost data to interpret results, to show trends weaknesses of operation, etc

Any or all of these activities may be carried on by a given trade association. All of them are interrelated and the activity of one type normally encourages activity in another. For example, the collection and dissemination of cost statistics encourage inquiries into the bases of these costs. These inquiries involve a consideration of definition of terms, items included, methods or principles followed, and in many cases lead to the adoption of organized cost systems for the use of members. Moreover, activities primarily of a nonaccounting nature may give rise to accounting implications which provide an impetus to further developments of a uniform cost program.

**STARTING A UNIFORM COST PROGRAM**—Development of a uniform cost program in any industry depends in many cases upon the leadership of one or more prominent members of the group or upon efforts of the trade association executive. Frequently the impetus is supplied by the efforts of government agencies as in the case of the

transportation and utility industries. When sufficient interest has been aroused, it normally leads to the creation of a special committee, often called the **accounting or cost committee**, and this body is directed to study the possibilities of uniform costing. If the latter is deemed feasible by the committee, a program is developed for presentation to the group. The committee should preferably be small, but representative of the association membership.

**ADOPTION AND INSTALLATION**—Ordinarily, the plan to be acceptable must not be so radical as to involve a complete abandonment of existing systems by individual members. Normally it means an adaptation of a company's own system to the new. Preferably this adaptation should be made in a series of gradual changes, none of which individually represents a serious disturbance to the normal routine operation of a company. In installing the system in individual member companies it is not enough to distribute manuals or forms and urge their adoption and use. Normally it is necessary for someone actually to visit a member company and get the program under way. This may be done by volunteer members of the cost committee or the industry at large, by qualified specialists put on the association's staff on a salaried basis, or through use of a retained public accountant or management engineer.

The complexity of the plan as compared with existing practice largely determines the time required for its installation and the amount of continuous supervision necessary. It also determines the cost of installing the system. These costs may be borne by the association and paid from its regular or a specially created budget, or the procedure may be to charge each member directly for services rendered. The method used in this connection must be carefully considered in its bearing on what will be the members' willingness to install the system.

The fact that so many trade associations have developed no uniform accounting plan for their members is evidence of the lack of interest that often exists in a given industrial group with respect to uniform costing. In many cases where leaders in the industry or trade association executives have endeavored to create interest in such plans, they have not progressed beyond the preliminary stages. The usual difficulties and objections are

- 1 Resistance to change
- 2 Keeping information confidential

**Resistance to Change**—This is a common cause of the lack of favorable action. A company which has a good system of cost accounting may dislike to disrupt or modify its system to conform to some newly devised uniform plan. Other companies with less complete systems may also resist change. While these latter companies stand to realize the greatest gains, nevertheless they often prefer to go on in the accustomed way and thus avoid the bother, effort, and allied activity which a new installation would involve. Many members may sincerely feel, moreover, that because of the varied conditions in the industry, their own systems better fit their needs, and that it is therefore impractical to attempt to formulate and put into practice a uniform plan. Finally there is often the objection to the expense involved. In this case the

member must be clearly shown that the benefits he will obtain from the new plan exceed the installation costs

**Keeping Information Confidential**—Where the uniform plan involves reporting cost data to the association secretary for consolidation and reporting back to the membership, some members become apprehensive that confidential information regarding their own operations may get into the hands of competitors and may therefore hesitate to report such data. In these cases procedures must be devised which assure the members that the source of information will not be disclosed. Obviously, unless a representative participation in the activities is secured from the membership, there can be no significant calculations of averages or norms for the general guidance of the industry

**Maintaining Interest**—Once a new system is installed and operating efficiently, the major work has been done. The next task consists of maintaining interest so that the gains made are not lost. Ordinarily the best means of protecting such gains made is to strive continuously to perfect the system still further and to expand the range of its activities by a maximum utilization of the results. This can be done through more complete analyses and reports furnished to the membership. Many systems have been started in a capable fashion, but have deteriorated and fallen into disuse because there was no organized program for maintaining interest in them or for the continued study of the possibilities of extending costing activities in a more constructive sense

**COST MANUAL**—In those cases where a uniform cost program is in effect, there is some document, bulletin, or more elaborate manual which is called the cost manual. This represents the formal evidence of the cost plan recommended and describes the nature and scope of the particular plan. The content depends upon the type and scope of cost plan, upon methods of presentation preferred by those who devised the actual plan, and upon the extent to which it is believed the need exists for educational material relative to cost accounting and even general accounting

**Purposes of Cost Manual**—The United States Chamber of Commerce, in its bulletin "Developing the Uniform Cost Manual," has covered the important features of good cost manuals. The purposes or characteristics of such manuals are

- 1 Selling appeal that is they should present in an interesting way the compelling reasons for the desirability of making use of uniform methods
- 2 Comprehensive reference book on accounting procedure
- 3 Usefulness to the executive and accountants in solving problems of installation of the recommended uniform methods

**Physical Characteristics**—Some questions to be considered are those of size, binding, printing, character of paper stock, and size and arrangement of exhibits. A printed manual has the advantage of being more easily read, requiring less paper than mimeographing, and it is possible to set up material in more attractive style. A loose-leaf arrangement is often preferred, either with a ring binder, or a binder employing posts or rivets and supplied with substantial fabric or leather covers. In size the sheet may well be the standard correspondence sheet, 8½ by 11 inches

Paper stock should be of good quality, able to withstand considerable handling. Folded exhibits are frequently necessary. Their number should be kept as small as possible.

**Scope of Manual**—If the industry consists of companies of similar size and a common range of products, it is entirely feasible to present the accounting procedure in one manual for use of all members. Where however there is great disparity in size of companies in an industry, the better plan is to issue a separate manual for large companies and one for the small.

**Character and Arrangement of Material**—The material may be presented in various ways

- 1 Descriptive method
- 2 Step by step method
- 3 Handbook method

Under the descriptive method the material is presented according to some logical accounting sequence nontechnical and technical description being interwoven. This plan makes for readability, and while likely to require more printed pages is frequently the easiest and most satisfactory to follow on the part of the reader.

The step by step method refers to the plan of exposition by which each step in the installation and operation of an accounting plan is presented in the order that would be taken by the member making the installation. It is open to the objection that it is uninteresting and requires high reader concentration.

By the handbook method, the accounting material is presented in logical concise accounting arrangement. Once the uniform system is installed, the handbook manual is of the greatest utility in that the accounting procedure may be quickly referred to and accounting problems readily solved.

**Cost and Financial Exhibits**—Forms of cost statements, balance sheets, profit and loss statements, and other similar exhibits are properly a part of a well-designed uniform cost accounting manual. Such exhibits must be thoroughly typical. By this is meant that the several exhibits should reflect conditions in the case of a member company. In some cases such exhibits have been prepared by the uniform cost accounting committee to show every conceivable item that might possibly appear. If the committee considers it wise to go into great detail with respect to the items found on the balance sheet, it would seem better practice to present the balance sheet in typical form and then in a supplementary exhibit to show the range of items that might conceivably be found.

**Classification of Accounts**—In most, if not all uniform cost accounting manuals, it is found desirable to include a classification of accounts. In some cases this is simply a classification of representative overhead expense accounts. In other cases it is an extensive classification of all accounts, controlling and subsidiary, that are found desirable in any units of the industry. The following points should be covered:

- 1 Precise definition of important debits and credits to each account
- 2 Suggested scheme of coding accounts, numerical, alphabetical, or mnemonic

Frequently the classification is extensive and requires many pages of printed matter. In some instances a skeleton outline of the classification is made a part of the description in the fore part of the manual reference being made to the detailed classification and definition of accounts at the back of the manual.

### Current Practice as to Uniform Cost Systems

**SCOPE OF SYSTEM**—The system developed may confine itself to a statement of general principles without attempting to outline the actual accounting system with records and related forms. Such a situation is illustrated by the Cotton Textile Institute's bulletin entitled "An Outline of Bases to be Used in Predetermined Costs for Guidance as to Sales Policies." The scope of this bulletin or manual can best be illustrated by noting the contents as presented in the manual itself.

- 1 Introduction
  - Definitions of cost
- 2 Normal production
  - Guard against tendency to overstate and consequent underestimation of cost
  - Reasons why production is under theoretical maximum
  - Normal production for day and night operations
- 3 Cotton and waste
  - Should be replacement cost
  - Method of ascertaining cost of cotton and waste
  - Sales of waste should be credited to cost
- 4 Depreciation
  - Must be allowed for all the time
  - Must be increased for day and night operation
- 5 Interest on investment
  - Items included in investment
  - Inclusion is justifiable and important
  - Indispensable to know relative cost of each fabric or yarn
- 6 Miscellaneous questions of labor and overhead
  - Labor
  - Supplies must not be treated as capital expenditures
  - Salaries
  - Stretch and size
  - Fuel consumed
  - Rents
  - Taxes
  - Idle machinery
  - Selling expense
- 7 Predetermined budget
  - General method of preparing and using
- 8 Assignment of costs to different products
  - Essential to sound results
- 9 Examples of incorrect methods
  - Unsoundness of averages per pound or per yard of average yarn numbers
  - Failure to assign payroll costs properly
  - Erroneous methods of assigning overhead
- 10 Proper distribution of overhead
- 11 Reconciliation of predetermined costs

## 12 General

- Standard weight
- Profit or loss per spindle and per loom
- Cost records
- Revision of cost system

The revised manual of the Cotton Textile Institute entitled "A Method of Predetermining Costs in Cotton Yarn Mills" uses hypothetical figures and by means of charts, tables, and a very limited amount of explanatory matter shows the actual application of the method. Again in this case no attempt is made to provide instructions for the actual accounting systems in terms of forms or records.

The Standard Glass Container Association's cost manual provides a good illustration of a more complete type of accounting system without actually providing forms and records. The list of sections in this manual is in part as follows:

- 1 Functions of a uniform cost system
- 2 Cost divisions
- 3 Voucher record
- 4 Cost ledger
- 5 Standards
- 6 Final cost
- 7 Bookkeeping procedure
  - Fixed journal entries
  - Chart of bookkeeping methods
- 8 Monthly reports to executives
  - Balance sheet
  - Profit and loss statement
  - Gain or loss from standard rates
  - Profit or loss by lines

Additional items covered include reserves, especially reserves for repairs of various kinds. Under the cost ledger heading detailed presentation and instructions occur covering all elements entering into the cost of production of glass containers. The instructions first are illustrated by the following except covering fixed charges:

By fixed charges we mean taxes, insurance and depreciation. All three of these are part of the operation cost. While taxes and insurance are only paid once a year and depreciation is solely a bookkeeping entry, yet each bottle must bear its proportionate share of this expense. In distributing these items of expense we will use the cost value of the buildings and equipment in each one of our cost divisions. The government has recommended this basis for depreciation and since all three are closely related we should use the same basis for all. It will be necessary first to determine these amounts for each cost division per year and then for a month.

An illustration of a more complete type of uniform cost system is provided by the Standard Cost Finding System of the United Typothetae of America (U T A), the trade association in the commercial printing industry. The general contents of this manual is as follows:

- 1 Principles and methods of accounting
- 2 Costs of production
- 3 Principles of the standard cost finding system
- 4 Explanation of expense divisions and overhead distribution
- 5 Departments of costs
- 6 Cost reconciliation and trading profit (or loss) for month where the all inclusive costs are used

- 7 Description of forms
- 8 How the system operates
- 9 Units of factory operations

Accompanying this manual are sample standard forms to be used in the operation of this cost finding system. These forms are as follows:

Form No

- 1 Instruction envelope
- 2 Individual order summary (see Fig 1)
- 3 Composition daily handwork report
- 4 Machine composition daily report
- 5 Monotype keyboard daily report
- 6 Monotype castei daily record
- 7 Daily press record
- 8 Cutter daily report
- 9 Folding machine daily record
- 10 Ruling machine daily record
- 11 Bindery daily hand report
- 12 Combination daily time report
- 13 Employees daily payroll
- 14 Weekly payroll sheet
- 15 Monthly individual payroll record
- 16 Monthly report of hand departments
- 17 Monthly record of machine departments (see Fig 2)
- 18 Yearly record of costs and production (see Fig 3)
- 19 Perpetual stock inventory record
- J Yearly and monthly schedule of fixed charges
- 9-HS (Small) summary of department costs for month
- 29-A Standard estimate form

All standard forms are available to members at a stated price.

In addition to the regular standard cost finding system there is available a similar manual and system for smaller printing establishments. This system bears the name of the UTA Simplified Cost Finding System. It includes only five forms as follows:

- 1 Instruction envelope
- 2 Individual order summary
- 3 Combination daily time report
- 4 Monthly individual chargeable and nonchargeable hours and payroll record
- 5 Summary of departmental costs for month

These forms are simplified adaptations of the corresponding forms in the regular system.

**STATEMENT OF BASIC POLICY**—The statement of principles ordinarily constitutes an important part of a good uniform cost program, regardless of whether a system of actual forms and procedures is developed or whether the program is confined to policies and general cost analysis. An excellent statement of principles and basic policy is found in the "Manual for Uniform Cost Accounting in the Cordage Industry," prepared for the Cordage Institute.

Uniformity in the cost accounting methods for an industry means that the same basic plan is used for cost keeping by the concerns interested. The plan is formulated so as to be elastic in its operation and is fixed only in the underlying principles. To illustrate a large manufacturer of prod







Monthly Record of Machine Departments														For Month of _____ 19__			
Machine No.										Mach. No.							
Q to	M to Road	Running	Non	Mach	Outlet	M to Ready	Re line	Rev	M to	Q to	Mach.	Q to	Q to				
to	to Road	On	to	to	to	to	to	to	to	to	to	to	to				
to	to Road	to	to	to	to	to	to	to	to	to	to	to	to				
1																	
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31																	

Fig 2 Monthly Record of Machine Departments



ucts probably would desire to keep records of manufacturing departments in more divisions than the smaller unit.

The application of uniform methods of cost accounting for a number of concerns may be summarized in three steps viz

- 1 Division of costs into the same elements
- 2 Charging similar expenses to the same element of cost
- 3 Uniform allocation or distribution of such charges to products

**Elements of Cost**—The main components of the selling price of a cord age product may be classified as follows

- 1 Cost of materials
- 2 Cost of direct labor
- 3 Factory operating expense
- 4 Administrative and home selling expense
- 5 Other distributing expense (including freight out and outside selling expense)
- 6 Profit

The first five elements make up the "cost to make and sell" a product. The cost of material, plus the cost of direct labor gives the "prime cost" and adding factory operating expense gives the "factory cost." When administrative and home selling expenses are added to the factory cost the "total comparable cost" for this industry is obtained. The addition of other distributing charges to this amount results in the "total cost to make and sell."

**Classification of Expenditures by Elements**—The second problem is to divide each of the major elements listed into detailed classifications with appropriate explanation of the items charged to each account. The companies adopting the uniform plan then set up these accounts in their records and charge expenditures as well as credit income in accordance with the rules laid down.

**Allocation of Expenses Against Products**—Departmental factory expense must be prorated on some reasonable basis and when it comes to prorating distribution and selling expense to products, such allocation must of necessity be largely arbitrary.

In practice, the mechanics of the necessary distribution must be carefully planned. The general plan of allocation is outlined in the section following the classification of accounts but all of Part II which is rather technical and quite specific as to methods, is devoted to the details of this subject.

Another illustration of a basic statement of principles is found in the "Manual of Job Cost Finding Practice for Miscellaneous Jobbing Steel Foundries," prepared by the Steel Founders' Society of America (1939). This manual sets forth the following general policies

- 1 The principles of the cost system must not be too complicated that is, they should be capable of being easily applied in every steel foundry regardless of the size of the plant or volume of business done.
- 2 The principles of the cost system, while not complex must be logical and practical.
- 3 The results obtained from a job cost system should show reasonable differences between the costs of simple and difficult castings. Some cost systems tend to produce costs which are not logically representative so far as showing the actual difference in costs of making different kinds of castings, that is, they tend to produce average costs of production.

- 4 The cost system should correctly reflect the close parallel which actually exists between the costs of producing the same castings in open hearth furnace foundries and in electric furnace foundries
- 5 Cost data representing actual performance of a large number of steel foundries should be used in the development of the cost system
- 6 Different methods of applying indirect and overhead expenses to individual castings should be studied compared and tested in order that the most satisfactory methods may be selected
- 7 General principles of applying indirect and overhead expenses to individual castings should be recommended subject to further refinements by those in a position to make them such as separate rather than average overhead rates for different kinds of molding and coremaking and for the different operations in the cleaning department
- 8 Clear definitions of the limits of each department should be determined and the definitions of what constitute direct labor and materials should be adopted

A brief description of the general principles of a job cost system recommended by this committee is the following

- 1 Cost of steel per net ton of good castings varies with yield
- 2 Molding department overhead expense is a percentage of molding direct labor cost
- 3 Core department overhead expense is a percentage of core direct labor cost
- 4 Cleaning department overhead expense is a percentage of cleaning direct labor cost
- 5 Annealing or normalizing cost pattern storage expense casting inspection cost and shipping expense are added together and charged to a specific casting at a fixed amount per net ton of good casting
- 6 Works burden expense is a percentage of the sum of all the above expenses and the total direct labor costs
- 7 Administrative and selling expense is a percentage of total works cost which comprises all expenses in the plant

Another illustration of a statement of principles may be taken from the "Manual of the Standard Cost System for Photo-Engravers" prepared by the American Photo-Engravers Association. This statement covers matters peculiar to the industry and is worded as follows

1 **Chargeable Hour Method**—For the purpose of arriving at the cost of production of photo engraving the standard unit of cost in the various departments shall be the chargeable hour, or hour of work performed on a customer's order

2 **Standard Hour Cost**—The standard hour cost shall be the gross cost inclusive of selling viz, direct labor plus all overhead expense, departmental, office or general commercial and selling expense

3 **Cost per Chargeable Hour**—This is found by dividing the total cost of the department including prorated expense, by the number of chargeable hours in that department

4 **Departmentalization**—The business shall be divided into departments each department being a natural division of the processes of manufacture. Also each department may be subdivided as much as desired

5 **Normal Costs**—The costs shall be ascertained monthly and by months added together until a period sufficiently long has elapsed to obtain a true average cost covering varying conditions. The correct basis is the average for the preceding twelve months

6 **Departmental Overhead Expense**—This expense shall be distributed to the departments which incur it.

7 **General Factory Overhead Expense**—The monthly amount of this expense shall be distributed over the factory departments at an average rate per chargeable hour. The average rate shall be secured by dividing the amount of expense by the total chargeable hours of all departments.

8 **Shipping and Deliveries**—This expense shall be kept as a separate department and absorbed through Administrative Expense in the hour costs.

9 **Selling**—The Selling Expense shall be kept as a separate account and the total expense absorbed through Administrative Expense in the hour costs.

10 **Administrative Shipping and Selling Expense**—These expenses shall be distributed over the various departments at an average rate per chargeable hour in the same manner as general factory overhead.

11 **Depreciation**—The original cost to the present owner of a machine or piece of apparatus its equipment and installation and also of furniture and fixtures is taken as the basis for depreciation. This expense, which represents wear and obsolescence is distributed over the departmental equipment in equal monthly instalments throughout its estimated life. Ordinary repairs and maintenance shall be considered as separate items of expense and shall not be included in depreciation. The cost of extensive replacements which substantially prolong the life of a machine shall be charged against the Reserve for Depreciation account.

12 **Rental or Real Estate Owned**—When buildings are owned the net expenses of ownership constitute the rental which shall be charged.

**DEFINITION OF COST FACTORS**—Since a statement of principles is ordinarily intended to set down certain general principles or policies, a further need exists for a more detailed and precise definition of cost and related cost factors as they exist in a particular industry. In some cases, as in the Photo-Engineers' manual, cited above, a statement of principles partially extends to this further problem of defining cost. In general, however, the treatment of cost elements is on a more detailed technical level. A good general illustration is provided by the manual of the American Institute of Bolt, Nut and Rivet Manufacturers from which the following is adapted:

**Material Cost**—Material cost is the cost of material that becomes an integral part of the product. It is estimated on the basis of the current purchase price of the material including extra charges plus the anticipated cost of freight and handling less the estimated value of scrap. It also includes the cost of boxes and containers in which the product is placed for display purposes or storage.

**Operating Cost**—Estimated cost of labor, depreciation, maintenance supplies power taxes insurance etc. charged either directly to production or marketing cost, or allocated to each of them in some proportion by analysis.

Operating cost represents the cost of producing and marketing the product exclusive of the raw material cost. It includes both direct labor and those other expenses which as a group, were heretofore commonly known as burden, overhead, indirect expense, load, or miscellaneous expense.

**Production Cost**—Production cost is the cost of manufacturing or producing the product and does not include the cost of material nor marketing cost. There are a number of ways in which elements of production cost may be distributed to the various items of product such as by building area, equipment value, labor, weight, etc. It is recommended, however

that costs of producing bolts, nuts and rivets are best assembled by the use of production center hour rates.

A production center is an area including machines or other equipment of like type, size and value for use in performing a specific operation. It may include a single machine, a group of like machines or just a bench for such operations as packing, inspection, etc.

A production center hour rate is the total estimated normal cost per hour of operation per machine at a production center. It is determined by dividing the total production cost allocated to a production center by the determined normal number of machine hours the production center should operate during a period of time.

Where machines of widely different characteristics are operated, which is the usual condition in the bolt, nut and rivet industry, accurate costs can be obtained only by the use of production center hour rates, since these rates bring out those large and important elements of cost that arise, for example, from:

- 1 Variation in the number of machines operated by one employee or by a group
- 2 Variation in machine values on which depreciation, taxes and insurance are calculated
- 3 Variation in floor space occupied by the machine
- 4 Variation in power required for different machines

**Marketing Cost**—The portion of operating cost that is allocated to marketing, and which is included in the normal cost as a percentage of the sum of production costs of all operations performed. It is the cost that would be incurred in selling, storing, and shipping the product if it were purchased in a finished condition ready for storage and delivery to the customer. The cost of selling, different classes of product does not vary in the same ratios as the costs to manufacture or the sales values. For these reasons, budgeted or standard rates must be established for each class of product so that selling costs can be applied properly.

Another illustration of the definition of cost elements is available from the "Cost Manual" of the Institute of Carpet Manufacturers of America, Inc.

**Materials**—It is assumed that all concerns have now in use or could readily obtain the following forms for the control of their raw materials and manufacturing supplies:

Purchase requisition  
Purchase order  
Receiving report

Inventory records  
Stores requisition

These cover the proper records to be kept concerning the purchasing vendors' invoice checking and the receipt and disbursement of materials and supplies through the stores. The checked invoice will then be entered into the voucher register and the materials concerned can be charged periodically to the proper ledger accounts. The purchases should be controlled by budgetary requirements and the inventory records contain "high" and "low" checking provisions. The stores requisition or a similar record makes possible the proper charging of the materials used to the type of product made.

**Labor**—The labor expenses are usually collected on the following forms:

Clock cards  
Piecework books, coupons, etc.  
Payroll

Monthly payroll summary  
Job order tickets



The summary gives the distribution to both direct and indirect departments and is adjusted by accrual figures to cover the fiscal month (unless a concern is closing its books on a 4 or 5 week period). The charges can be made directly to the labor accounts on the factory ledger. The job order tickets for repairs, etc., allow proper distribution of the indirect labor to the overhead accounts.

**Overhead**—Overhead charges to the several indirect departments will be made on the factory ledger from the Voucher Register (summarized for this purpose). This will apply to all outside service, supplies used, and all items of factory overhead expense, except supplies, etc., which are carried

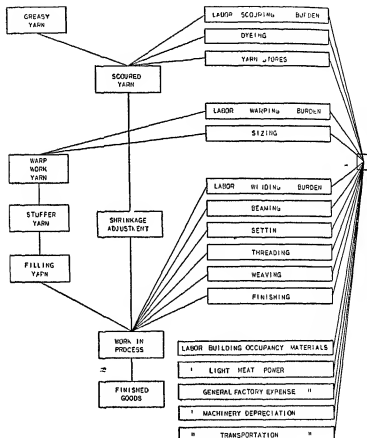


FIG 4 Flow Chart of Cost Elements

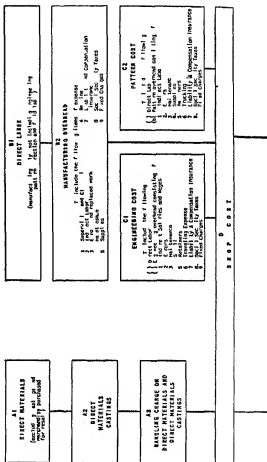
in stores and which will be requisitioned from the store's account and excepting labor, which will be charged to this group of accounts directly from the Payroll summary

The chart accompanying this explanation (Fig 4) shows the elements of cost and the procedure followed in the accumulation of the factory costs of finished merchandise. With this cost procedure and the chart showing the elements of cost along with the chart of accounts, comparison may be made with the systems in use, and installation made of any features which it is deemed to add to obtain more uniform results.

It is intended to cover only the broad cost principles which should be used and the methods for obtaining practical estimates without going into the detail of interdepartmental accounting and the accumulation of information which naturally differs with each plant. We are however adding a section on predetermined or standard costs and the establishing of standards so those plants which do not have standard costs and which may desire to compare actual with standard costs may use this as a guide.

Another illustration of cost factors is that of an association in an industry manufacturing heavy industrial equipment. In this case cost factors are presented in the form of an outline chart (Fig 5). Each factor on the chart is then briefly defined. The following quotation covers that part of the chart to and including B2 Manufacturing Overhead and illustrates the general procedure followed by this association.

- A1 Direct Materials (excluding castings and merchandise purchased for resale). All materials required in manufacture which can be charged to a specific order or orders at current delivered market cost.
  - A2 Direct Materials (Castings). All castings made or purchase which can be charged to a specific order or orders at current delivered market cost.
  - A3 Handling Charge. To the current delivered market cost of direct materials and to the current delivered market cost of castings shall be added an amount for handling charges.  
Procedure: An amount equal to the handling charge is to be credited to General or Administrative Expense E.
  - B1 Direct Labor. All wages paid except those for engineering patterns, erection, and field manufacturing, which can be charged to a specific order or orders. Such wages shall not include the wages paid for moving, storing, shipping or handling material and for standard painting or any overtime bonuses paid on direct labor. Wages of this character shall be charged to overhead (either manufacturing or general).
  - B2 Manufacturing Overhead
    - a Supervision and clerical
    - b Indirect labor
    - c Errors and replaced work
    - d Maintenance
    - e Supplies
    - f Retainers. All bonuses paid for overtime, lost time, vacations or incentive bonuses
    - g Liability and compensation insurance
    - h Social security taxes
    - i Fixed charges (manufacturing portion)
- Procedure: B2 Manufacturing Overhead to be applied to Direct Labor B1.



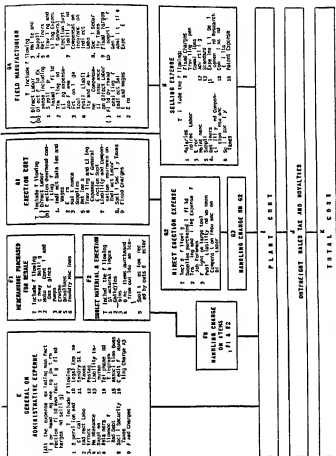


FIG 5 Diagram of Relationships Among Uniform Cost Components



**TREATMENT OF GENERAL ACCOUNTING**—The success of any uniform cost program depends upon the kind of general accounting systems being operated. This is especially true when the cost system is made an integral part of the entire system and where cost accounts are definitely tied in to the general books. For this reason some associations go farther than others in developing a general accounting program for members, and in presenting to them general or basic aspects and principles of accounting which other cost manuals assume to exist. This is most likely to be the case when units of the industry are relatively small. The interrelationship of the cost accounting system with the general ledger is illustrated in an excellent manner by a chart from the manual of the Coidage Institute (Fig. 6).

**TREATMENT OF DISTRIBUTION COSTS**—The uniform cost activities of trade associations have been confined chiefly to the field of manufacturing accounting with such further treatment of general accounting aspects as seemed advisable in particular cases. In recent years, however, considerable interest has developed in studying costs of distribution. Special studies of the problem have been made by such associations as the National Wholesale Druggists' Association and the Institute of Meat Packers. Undoubtedly the need for knowledge in this field and the competitive aspects of distribution costs within a typical industry have caused trade associations to give attention to these problems. A significant effort is the "Manual—Selling and Distribution Costs" of the Institute of Carpet Manufacturers of America, Inc. (1937). The purpose of this manual is outlined in the introduction as follows:

The purpose of this manual is to further develop among the members of our industry a clearer understanding of selling and distribution costs and to provide information as to the general procedures used or available for the proper measurements of cost for those functions which come after the Factory costs.

Cost keeping records which properly measure selling and distribution costs are relatively as important as factory costs. First it makes the knowledge of these costs available continually to the executives to assist them in determination of policy and the controlling of these expenses. Also it makes possible continual comparison between estimates and standard costs upon which prices are based, with the actual expenditures made.

It enables the management to determine which are the best lines to sell profit wise and which territories are creating the best returns. It aids in the analysis of all selling and distribution cost factors as they apply to lines, branch offices, distributors, size of orders, sales and advertising policies and other factors met in securing orders and making the products available for sale and use.

The procedures outlined are quite generally used in many industries, and may be used by those mills which have complete cost systems to compare with their present methods and also provide a guide for those who have not as yet made these cost segregations.

Accurate predetermined costs should always be used as a basis for naming selling prices and the profitability of the industry as a whole is affected when incorrect and inaccurate flat percentages are used in their place.

The final section of the manual represents an excellent general statement of what the membership may expect from this type of accounting.

- 1 A proper segregation of your costs for these functions apart from your general costs
- 2 The distribution of your expense accounts by the factors which apply will enable you to make a study of the functions of selling and by setting up standards will enable periodical comparisons with actual expenses and assist you in controlling these costs
- 3 Separate costs may be obtained for selling the wholesale trade the retail trade the mail order trade and the industrial trade so that periodical comparisons may be made
- 4 The cost of selling orders of various sizes may be ascertained for the purpose of general sales policy studies and the elimination of unprofitable sections customers or types of orders
- 5 The cost of selling by separate territories may be ascertained so that unprofitable sections may be considered and the separate classes of trade and types of product sold may also be compared territorially
- 6 The cost of selling and distributing each general type of product and all special products may be obtained
- 7 Special studies may be made from the data assembled and analysis of results by customers by salesmen, and other information you may need from time to time or to meet new conditions

It is suggested in order to approach these problems that you make some preliminary studies to measure the several factors needed to assist you in your expense distribution, then select a month and go through the operations suggested to obtain the data mentioned covering the results you wish to obtain

Another good illustration is that of the National Association of Printing Ink Makers in their "Manual of Standard Cost Accounting for Printing Ink Makers" The elements entering into both manufacturing and distribution costs are clearly shown in Fig 7 The general attack on distribution costs is illustrated by the following section taken from the same manual

**Recording Distribution Costs**—The three classes of expense making up distribution cost (Fig 7) are to be recorded in the accounts provided therefor in the list of accounts For each main class of distribution expenses a set of accounts is to be kept These accounts furnish an adequate analysis of the expenses

Distribution expenses do not increase the inventory value of finished stock and no part of such expenses is to be included in the manufacturing labor and burden costs All of the distribution expenses incurred each month are to be applied against the operations for the month and are to be included completely in the Profit and Loss statement under the heading of Distribution Costs

**Applying Distribution Costs to Individual Orders**—Distribution costs differ widely as between individual orders depending on size of order and type of container in which the ink is filled These differences in cost frequently are not recognized because no steps are taken to determine how the costs run

The principal advantage of following out the below described procedure for applying distribution costs to individual orders is that it enables each member to set prices with a full knowledge of what cost is involved on each order

**Packing and Shipping Expense**—To determine how these expenses are to be applied to individual orders the following procedure is to be used A study is to be made of the various packing and shipping expenses to find out how they are affected by different sizes of orders and types of con

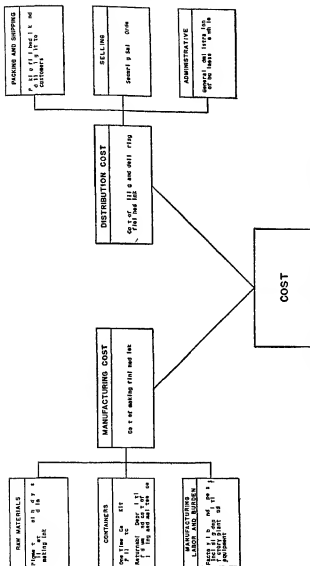


FIG 7 Manufacturing and Distribution Cost Elements



times Packing and shipping operations are considered under three heads

- 1 Banding and labeling
- 2 Packing
- 3 Delivering

**Banding and Labeling**—To establish the banding and labeling cost for each size container it is necessary to make a study of the time required to band and label each and to figure the cost of labor involved. Banding and labeling a one pound container takes about the same time as banding and labeling a five or ten pound container. This results in a much higher banding and labeling cost per pound on a one pound container than on the larger containers.

**Packing**—Packing cost includes the cost of cases cartons wrapping paper, excelsior and similar direct packing supplies and labor cost of the man performing this operation. This cost also varies widely with the size of the shipment and container. An order consisting of 250 pounds of black in 50 pound kits can be packed in a short time while an order for the same quantity of black in five pound cans takes considerably longer.

The study of packing costs therefore must be made according to the different sizes of orders and types of containers and must include a determination of the cost of supplies and labor involved on each.

**Delivery**—An analysis of delivery cost shows the wide range between the cost of delivering different sized orders between for example delivering a five pound package by a boy and delivering a 100 pound package by truck.

The above three items of packing and shipping expense can be determined per order with reasonable accuracy if sufficient time and care are taken in studying them. There is a fourth item of packing and shipping expense however which is general in nature and which is to be applied to each order on a per pound basis.

This fourth item covers salaries and wages of packing and shipping employees not engaged in banding labeling packing or delivery operations (for example foremen, etc.), general packing and shipping supplies (other than cases cartons paper excelsior, etc.), repairs and maintenance of Packing and Shipping department equipment (other than automobile trucks) share of power and light, share of fixed charges and any other packing and shipping expenses of a general nature.

Some members of the printing ink industry have developed and use packing and shipping costs per pound for various size orders and various size containers. Excluding the item of general packing and shipping expense which varies with individual conditions the following table shows approximately the costs developed by a medium size manufacturer.

	Cans			Kits
	5 1's	10 1's	10 10's	5 50's
Banding and Labeling,	\$ .16	\$ .25	\$ .50	\$ .25
Packing,	.08	.12	.25	
Delivery,	.40	.40	1.00	1.75
Total	\$ .64	\$ .77	\$ 1.75	\$ 2.00

It will be seen from the above that exclusive of general packing and shipping expenses the member figures the packing and shipping cost on five one pound cans to be \$ .64 or \$ 1.28 per pound on ten one pound cans to be \$ .77 or \$ .77 per pound on ten ten pound cans to be \$ 1.75 or \$ .18 per pound and on five fifty pound kits to be \$ 2.00 or \$ .08 per pound. As stated in addition to the above cost there is the item of general packing and shipping expense.

**Selling Expense**—The amount of selling expense to be applied to an individual order is to be based mainly on the sales value of the order. An exception however is to be made in the case of certain sales office costs which are to be applied on a flat per order basis that is uniformly to all orders regardless of size.

This flat per order cost is to cover the clerical cost involved in handling orders. It includes typing the sales forms, figuring the invoices, invoicing the shipments, keeping the customers' accounts and collecting the accounts. An analysis of these clerical costs is to be made from past records. The total of these costs for a suitable period is to be divided by the total number of orders handled in the period and a cost per order obtained. This cost per order will usually be found to be quite large.

The total of the other selling expenses for the period selected is to be divided by the amount of the sales during that period to determine the percentage that the expenses bear to the sales.

In figuring the selling costs on individual orders, the per order clerical cost and the amount obtained by multiplying the sales value of the order by the percentage to cover general selling expenses are to be added together to get the total selling expense applicable to the order.

**Administrative Expense**—The total administrative expense for a suitable past period is to be divided by the sales during that period to find the percentage that the expense bears to the sales. This percentage is to be applied to individual sales order amounts to determine the administrative

the last twelve months by the sales during those months. Thus in January the percentage would be based on figures for the previous twelve months from January through December. In February on figures for the previous twelve months from February through January. In March on figures for the previous twelve months from March through February and so on.

**OPERATING AND FINANCIAL REPORTS**—The majority of uniform cost programs outline the forms to be used in the preparation of operating and financial reports. The nature and scope of these reports largely reflect the content of the system itself. Where for example, a cost system has utilized standard costs, schedules are outlined which show variations from actual cost. Where costs have been developed by product lines, the system normally presents summary reports utilizing these data. In many cases balance sheets and profit and loss statements are presented, and in the more detailed systems these are explained in considerable detail. Typical of such presentations is the treatment explaining report forms found in the manual of the Coidage Institute.

A form suitable for recording current costs is shown in Fig. 8. Current costs are obtained by the application of various ratios to the estimated standard costs.

CURRENT COSTS							
PRODUCT		%	DATE		DATE		
COSTS PER LB			CURRENT COST	REPLACE MENT	CURRENT COST	REPLACE MENT	
	FIBRE COST						
	OIL						
	NET FIBRE PER CWT OF PRODUCT						
	NET FIBRE AND OIL						
	TARS TALLOWES ETC						
	PACKING MATERIALS						
	DIRECT LABOR						
	EXPENSE						
	TOTAL FACTORY COST						
	ADMINISTRATIVE EXP						
	HOME SELLING EXP						
	TOTAL COMPARABLE COST						
	OUTSIDE SELLING COM MISSIONS ETC						
	FREIGHT OUT						
	TOTAL COST						
MARGIN	CASH DISCOUNT						
	TOTAL						
	PROFITS TAX						
	STANDARD PROFIT						
	INDICATED SELLING PRICE						
FIBRE MIX							

FIG 8 Operating Report



The division of current costs into elements shown on the form further facilitates the setting of minimum sales prices whenever these are necessary. Should any form of cost control be exercised in the industry both the divisions and totals along these lines seem to be essential.

By computing the differences in total costs of various sizes and kinds of products as shown on the current cost records it is possible to set differentials from base prices which allow profit margins for each of the range of sizes of a product in proportion to the profits for the base size.

The same manual recommends the use of monthly balance sheets and then proceeds to discuss the monthly profit and loss statement (Fig 9). The latter shows profit and loss figures by classes of cordage and at the same time presents an analysis of these figures on a unit (per pound) basis. This is followed in the manual by a discussion of labor and factory expense in relation to the general question of operating efficiency.

**Direct Labor Costs by Departments**—Two important problems relating to factory management, particularly in concerns which pay factory labor partly or entirely on a day work basis are (1) how to judge the efficiencies of factory departments and (2) how to maintain a check on the labor pay rolls of each department. With minimum wages and scheduled hours enforced by government control it becomes all the more important to watch manufacturing efficiencies and cost because the only method of reducing cost will be by obtaining greater efficiency.

In attempting to control and judge the efficiencies of various departments some of the cordage concerns not utilizing this system prepare statistics on the production per capita per hour in each manufacturing department. Such figures are good, but it is impossible to take into account properly differences in the kinds and sizes of products manufactured during a period. It is similarly not possible to compare production per capita between departments.

As an aid in the solution of this difficulty the departmental report is reproduced (Fig 10). This report results from regular accounting procedure and the direct labor ratios should be prepared each week when the system is first instituted although monthly figures are sufficient subsequently. Departmental expense figures should be prepared monthly only.

The ratio of actual direct labor cost to the standard affords an excellent indication of the departmental operating efficiency. As stated previously the method of computation is such that the kinds and variations in sizes of products are taken into consideration so that the ratio is an index of the labor efficiency of the department regardless of type of product run. By watching the trend of these ratios from period to period good control over labor activity may be obtained and further the ratios may be used for judging the results in the various manufacturing departments compared with each other.

**Factory Operating Expenses by Departments**—Fig 10 gives not only the direct labor performance for each department but the actual expenses incurred by items are indicated also. Such actual expenses are set next to the budgeted expenses and any large differences between actual and budget should be investigated. Sundry other information of interest such as volume of operation in relation to normal and the effect of this volume on cost is also shown so that the report constitutes a complete record of departmental activity.

**Centralized Information for Industry**—The major objective of a uniform cost program normally is to supply the management of individual companies with information essential to an intelligent operation of the business. There is, however, another important objective, that of developing uniform data for consolidation and analysis at the central



Accounts	Number of Reports								Com posite
	Class A Sales Less Than \$15 000	Class B Sales \$15 000 to \$35,000	Class C Sales \$35 000 to \$75 000	Class D Sales \$75 000 to \$150 000	Class E Sales \$150 000 to \$300 000	Class F Sales \$300 000 to \$500 000	Class G Sales \$500 000 to \$750 000	Class H Sales \$750 000 and Over	
	14	60	84	61	47	20	8	11	305
(5) Paper	19 70	21 52	19 42	22 97	19 55	19 48	19 69	25 84	22 52
(6) Ink	64	1 22	1 53	1 70	1 95	1 96	3 31	3 63	2 66
(7) Bindery Materials	31	70	1 82	1 46	1 40	52	1 84	3 34	91
(8) Miscellaneous Purchases	8 37	10 45	10 38	9 62	12 22	10 68	8 82	7 72	9 43
(10) Total Materials Used	29 02	33 89	33 15	35 75	35 12	32 64	33 66	37 52	35 52
(11) Stock Storage and Handling Ex pense	10	13	13	20	38	74	27	39	38
(13) Rent	4 30	3 48	2 86	2 71	2 33	2 72	1 73	1 21	1 99
(14) Insurance	72	74	67	51	41	30	31	23	35
(15) Property Taxes	42	53	69	45	42	33	66	94	67
(16) Depreciation on Equipment	4 18	3 48	3 04	2 78	2 56	2 35	3 27	2 80	2 78
(17) Total Factory Fixed Expenses	9 62	8 23	7 26	6 45	5 72	5 75	5 97	5 18	5 79
(18) Wages	26 43	24 51	27 95	26 91	27 19	30 55	30 27	28 31	28 30
(19) General Factory Expense	1 10	2 30	2 37	2 02	2 23	2 12	2 69	4 42	3 12
(20) Departments Direct Expense	3 94	1 38	1 26	1 49	2 04	2 18	2 88	2 02	2 23
(21) Factory Social Security Taxes	42	1 78	1 62	1 02	99	1 07	1 16	1 41	1 18
(22) Light	64	30	37	35	30	24	66	30	30
(23) Power	52	65	69	76	67	63	66	58	64
(24) Spoilage	02	09	23	20	30	25	15	27	25
(25) Total Factory Current Expenses	33 07	30 01	33 81	32 75	33 72	37 04	37 98	37 91	36 02
(29) Work in Process (Increase—Decrease)	15	18	16	33	51	1 03	54	95	70
(30) Factory Cost of Goods Sold.	71 68	72 08	74 19	74 82	74 43	75 14	77 34	80 05	77 01
(31) Gross Profit on Sales	28 32	27 92	25 81	25 18	25 57	24 86	22 66	19 95	22 99

(33) General Expense	2 59	1 56	1 62	1 32	1 50	1 67	1 10	79	1 19
(34) Office Expense	1 81	1 49	1 36	1 19	1 92	90	51	73	1 89
(35) Packing, Shipping and Delivery	86	84	1 06	1 19	1 02	1 24	1 82	1 77	1 43
(36) Salaries (Executive)	12 63	11 27	8 06	7 11	5 00	4 24	3 83	1 37	4 11
(37) Salaries (Clerical)	4 64	3 93	3 53	3 40	3 50	2 82	2 82	1 92	2 76
(38) Bad Debts	1 06	77	60	55	64	65	30	1 07	27
(39) Social Security Taxes	1 31	28	41	51	42	39	13	11	47
(40) Fixed Expenses (Rent, Ins., Taxes, Depreciation)	1 18	29	60	41	41	83	61	35	47
Total Administrative Expenses	26 13	20 43	17 89	15 72	14 01	13 14	11 12	8 09	11 92
Total Cost of Completed Product	97 81	92 51	92 08	90 54	88 44	88 28	88 46	88 14	88 93
(43) Selling Salaries	1 88	3 52	3 59	4 31	4 58	3 83	2 79	1 30	2 87
(44) Commissions	18	94	1 01	1 30	2 10	1 94	2 90	3 85	2 66
(45) General and Traveling Expenses	72	1 23	1 43	1 53	2 13	1 54	97	98	1 35
(46) Advertising	95	1 12	1 11	89	1 02	1 50	80	46	1 07
(47) Social Security Taxes	01	06	06	11	16	13	09	05	08
(48) Fixed Expenses (Rent, Ins., Taxes, Depreciation)	01	12	08	18	18	14	11	11	13
Total Selling Expenses	3 78	6 98	7 28	8 32	10 17	8 17	7 25	6 75	7 76
Total Cost of Sold Product	101 59	99 49	99 36	98 86	98 61	96 45	95 71	94 89	96 69
(51) Net Profit on Sales	1 59*	51	64	1 14	1 39	3 55	4 29	5 11	3 31
(3) Net Sales	100 00	100 00	100 00	100 00	100 00	100 00	100 00	100 00	100 00
(57) Financial Income and Expense (Income--Expense)	63	57	43	57	02	25	02	24	16
(62) Other Income and Expense (Income--Expense)	1 03	34	85	33	18	13	47	19	02
(63) Total Net Income	1 16*	48	76	1 10	1 59	3 93	3 80	4 08	3 18
(2) Sales Allowances	03	21	30	21	33	18	10	19	22
(1) Gross Sales	100 03	100 21	100 30	100 21	100 33	100 18	100 10	100 19	100 22

\* Loss

Fig 11 Ratios of Operating Expenses and Profits to Sales





## COSTS PER CHARGEABLE HOUR

Wage Cost	\$1 885	2 079	1 786	965	973	903	830	1 113	908	1 274
Fixed Expenses, Cont.	180	284	113	462	130	109	141	159	253	355
Other Factory Expense Cost	594*	430	415	503	288	315	337	315	376	501
Total Factory Cost	2 659	2 802	2 314	2 020	1 291	1 478	1 308	1 537	1 627	2 110
Commercial Cost	370	340	388	284	260	312	255	235	317	346
Selling Cost	411	381	365	276	278	374	290	356	413	280
Stock Storage and Handling										
Packing										
Shipping and Delivery Cost	194	248	109	108	170	164	127	187	221	244
Total Departments All Inclusive Cost per Chargeable Hour	3 634	3 771	3 176	2 683	2 097	2 328	2 080	2 365	2 573	3 080

## TOTAL HOURS

Total Chargeable Hours	609 235 0	271 817 9	61 455 4	99 984 4†	74 921 6	50 454 8	49 830 5	42 638 5	51 922 177	31 07 662 6
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## PERCENTAGE OF PRODUCTIVE TIME

Percentage of Hand Productive Hours to Total Payroll Hours	67 2									
Percentage of Machine Productive Hours to Possible Hours	82 3		55 1	52 3	30 0	31 0	44 1	48 3	59 6	75 4

\* Includes Machine Cast Type Expense.

† Includes both Sorts and Machine Cast Type Hours

FIG 12 Operating Ratios

office of the trade association for the general benefit of all members of the industry. Once a uniform cost program of a satisfactory nature has been established and is operating as designed, it is a natural development that the total results of all members should be analyzed and interpreted. These results then provide a valuable yardstick for each member as to inefficiencies or defects of operation, and should under normal circumstances make for a more intelligent and efficient administration of individual companies. One of the most outstanding examples along these lines is provided by the United Typothetae of America. Building upon a uniform accounting program, the association has for many years assembled and reviewed the financial results of individual members. These summary results are analyzed and interpreted in the form of significant ratios and presented annually to the membership for help and guidance of the industry. The following is a digest of the table of contents of the edition released in 1940 covering 1939 results.

- 1 Ratios as an aid to management
- 2 The financial statements
  - a 1939 composite balance sheet
  - b 1939 composite operating statement
  - c Comparison of 188 financial statements, 1938 and 1939
- 3 Analysis of the individual statement
- 4 Balance sheet analysis
  - a Balance sheet ratios, composite and by classes
  - b Chart of ratios from the 1939 composite balance sheet
- 5 Ratios for credit measurement
- 6 Operating statement analysis
  - a Ratios of operating expenses and profits to sales
  - b Ratios of operating expenses and profits to sales in plants having 6% or more profit
  - c Ratios of expenses to total cost of sold product exclusive of materials
  - d Ratios of expenses to total cost of completed product exclusive of materials and selling expenses
  - e Condensed ratios of factory, administrative, and selling expenses to sales
  - f Chart of ratios from the 1939 composite operating statement
- 7 Ratios of plants having a profit and those showing a loss compared with the composite results
  - a Ratios of operating expenses profit and loss to sales
- 8 Printing barometers
  - a Chart of index of printing activity since 1923
  - b Per cent profit on net sales
  - c Profit on investment based on 263 balance sheets with accompanying operating statements
  - d Chart of profit and loss analysis per sales dollar for twelve years
  - e Highlights in the 1939 composite statements
- 9 Comparative ratios for consecutive years
  - a Balance sheet ratio analysis for twelve years
  - b Ratios of operating expenses and profits to sales for ten years
  - c Ratios of sales to gross plant investment for ten years
- 10 Departmental cost analysis
  - a Ratios of department expenses, hour costs, and percentages of productive time
  - b Total dollars with ratios of expenses to total all inclusive cost
  - c Percentages of productive hours for twenty years
- 11 Budgeting Break even chart of 1939 composite operating statement results

Operating Statement						Period ending		194
Classification	Ratios		Amounts of this Company	Amounts Based on Group Ratios	Variation		Over	Under
	Group Ratios	This Company						
Materials Used			\$	\$				
Stock Storage and Handling Expenses								
Factory Fixed Expenses								
Factory Wages								
Factory Current Expenses								
Work in Process (Increase-Decrease)								
Factory Cost of Goods Sold								
Gross Profit on Sales								
Administrative Expenses								
Cost of Completed Product								
Selling Expenses								
Cost of Sold Product								
Net Profit on Sales								
Net Sales	100.00	109.00						
Financial Income and Expenses (Net)								
Net Operating Profit								
Other Income and Expense (Net)								
Total Net Income								

Fig 13 Work Sheet for Readjustment of a Concern's  
Figures on the Basis of Industry Average

Figs 11 to 13, taken from the above source, show the wide coverage of the analysis. Fig 11 is an analysis based on the profit and loss statement in ratio form showing the ratios of operating expenses and profits to sales for different classes of brewing establishments according to the latter's size. Fig 12 covers departmental analyses of operating expenses

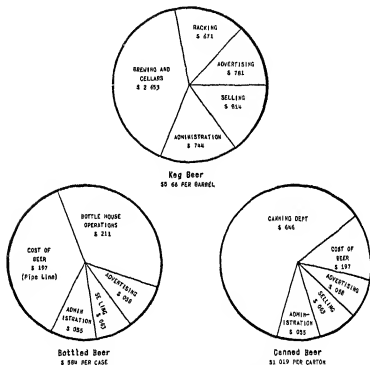


FIG 14 Pie Charts of Cost Elements

and other statistical data. Of special interest is Fig 13, representing a suggested form of work sheet for use by individual concerns in comparing their own figures with the industry averages for their particular classes. Any unfavorable results disclosed by this analysis should furnish a stimulus to bring the individual plant figures in line with the industry's averages.

The United States Brewers' Association in its "Study of Brewery Costs for 1939" has similarly made a study of the brewery industry's problems and costs, and presented the results based on a questionnaire

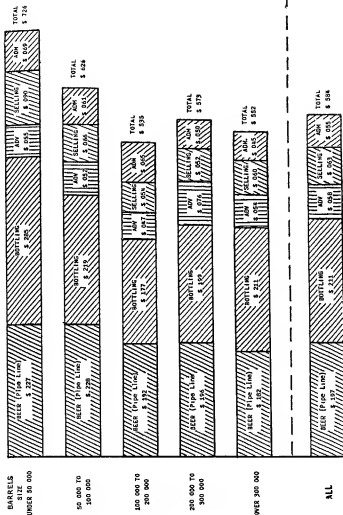


FIG 15 Bar Chart of Comparative Costs

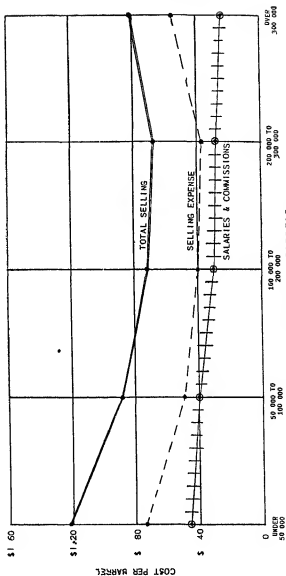


Fig 16 Lane Graph of Comparative Costs

sent out to its members. The report covers the topics shown below each topic being illustrated by tables and charts

- 1 Scope of survey
  - a Zone and size distributions of respondents
  - b Map showing geographical distribution of respondents
- 2 The over all picture total keg bottled and canned beer costs
- 3 Breakdown by cost elements material, labor and overhead expense.
  - a Brewing, cellar and racking costs
  - b Bottling costs
  - c Canning costs
- 4 Plant costs by geographical zones
- 5 Total costs by areas
  - a Keg goods costs by areas
  - b Bottle goods costs by areas
- 6 Costs by size of brewery
  - a Keg goods costs by size of brewery
  - b Bottled goods costs by size of brewery

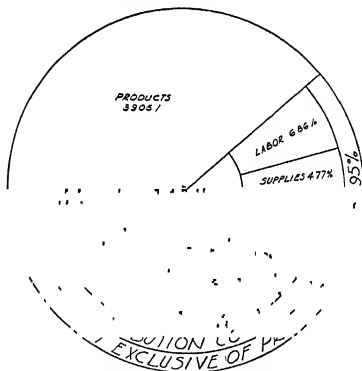


FIG 17 Pie Chart of Costs by Major and Subfunctions



- 7 Costs of large versus small breweries
  - a Overall costs of large versus small breweries keg and bottled goods
  - b Detailed costs of large versus small breweries
  - c Costs by size by zones
- 8 Advertising costs advertising costs per barrel sold by size and by zones
- 9 Selling costs
  - a Selling costs per barrel sold by size of brewery
  - b Selling costs by zones

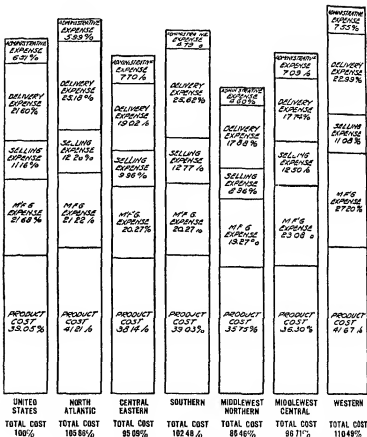


FIG 18 Bar Chart of Comparative Costs by Districts

- 10 Administration costs
  - a Administration costs by size of brewery
  - b Administration costs by zones
- 11 General overhead costs overhead costs by major items

Figs. 14, 15, and 16, taken from the above report, illustrate the general approach and treatment. Fig. 14 shows in the form of pie charts the



## Legal Status of Uniform Cost Methods

### GENERAL LEGAL STATUS OF TRADE ASSOCIATIONS

—An interpretation of the legal status of trade associations and their activities must rest to a considerable extent upon a proper historical perspective. Because of uniform methods of cost keeping prevailing in an industry, uniformity in price policies is apt to develop as a by-product. It is, in fact, difficult to say where cost accounting ends and price fixing begins. Generally speaking, however, the law frowns on all price fixing attempts by individuals or trade associations.

The material presented on the legal status of trade associations and their methods has been drawn in part from the study by the National Industrial Conference Board (Trade Associations: Their Economic and Legal Status), from Kirsh (Trade Associations in Law and Business), and from a special study prepared for the Temporary National Economic Committee (Substantive Law of Restraint of Trade, Monopoly, and Unfair Competition).

The trade association is subject to the same legal principles as any form of business organization in being judged as to whether it is violating the law of the land. It is judged by the purposes for which the association members are banded together and by the means employed to achieve their ends. Certain activities are clearly prohibited under existing law as clarified by court decisions and those of the Federal Trade Commission. At the other extreme are many activities which give rise to few, if any questions of legitimacy from the point of view of public policy, and which accordingly are beyond question within the scope of the law. Between these two extremes is an area where the final judgment is not clear. Here the activities are scrutinized closely as to their implications in the light of the currently accepted tests or principles. These tests or principles are, of course, constantly changing as new pronouncements and decisions further clarify borderline situations. The

courts in general have applied three doctrines in judging the legality of trade association activity

- 1 Doctrine of restraint of trade
- 2 Doctrine of conspiracy to monopolize
- 3 Doctrine of unfair competition

Objective sought by the courts in all cases was to preserve a free and open market and thus to maintain conditions which would most stimulate the economic development of the nation and best serve the national welfare. In addition, the important factor of governmental policy must be considered. A liberal policy in enforcing the Sherman and Clayton Acts during 1934 and 1935 is to be contrasted with the more vigorous study and activity of enforcement agencies since that period. The tests or principles are in part influenced by the mood and temper of the times. History, however, does bear testimony that, save for some exasperating delays, the law ordinarily tends toward an interpretation of economic practices which best serve the legitimate needs of the business community. That trade associations do have a legitimate sphere of activity is hardly to be questioned.

**STATISTICAL REPORTING ACTIVITIES**—The legal status of statistical activities, including both the usual trade statistics and information relative to costs and prices, is determined largely by five Supreme Court cases. These are

American Column & Lumber Co v United States, 257 U S 377  
 United States v American Lined Oil Co, 262 U S 371  
 Maple Flooring Mfrs Assn v United States, 268 U S 563  
 Cement Mfrs Protective Assn v United States, 269 U S 588  
 Sugar Institute Inc v United States, 297 U S 553

The American Column & Lumber Co case, commonly referred to as the Hardwood case, was the first court pronouncement and was considered exceedingly hostile to statistical activities of trade associations. The most unfavorable interpretation was given to the statistical activities of the individual members, and the plan was declared to be illegal. The court said:

Genuine competitors do not make daily weekly and monthly reports of the minutest details of their business to their rivals as the defendants did; they do not contract as was done here, to submit their books to the discretionary audit and then stocks to the discretionary inspection of their rivals for the purpose of successfully competing with them; and they do not submit the details of their business to the analysis of an expert jointly employed, and obtain from him a "harmonized" estimate of the market as it is and as in his specially and confidentially informed judgment, it promises to be. This is not the conduct of competitors but is so clearly that of men united in an agreement express or implied, to act together and pursue a common purpose under a common guise.

The "Plan" is, essentially, simply an expansion of the gentlemen's agreement of former days, skillfully devised to evade the law. To call it open competition because the meetings were nominally open to the public, or because some voluminous reports were transmitted to the Department of Justice, or because no specific agreement to restrict trade or fix prices is proved, cannot conceal the fact that the fundamental purpose of the "Plan" was to procure "harmonious" individual action among a large number of naturally competing dealers with respect to the volume of production and prices.

The Linseed case was similarly unfavorable, and in this case likewise the plan was held to be illegal. While the Maple Flooring case dealt with still another set of facts, it was characterized by a judicial attitude of sympathy and understanding which had been previously indicated in dissenting opinions to the Hardwood and Linseed decisions, and in this latter case the plan was held to be legal. The decision here has been called the most liberal view which the Supreme Court has definitely announced. In the words of the court:

It is the consensus of opinion of economists and of many of the most important agencies of Government that the public interest is served by the gathering and dissemination in the widest possible manner of information with respect to the production and distribution costs and prices in actual sales of market commodities, because the making available of such information tends to stabilize trade and industry, to produce fairer price levels and to avoid the waste which inevitably attends the unintelligent conduct of economic enterprise. Free competition means a free and open market among both buyers and sellers for the sale and distribution of commodities. Restraint upon free competition begins when improper use is made of that information through any concerted action which operates to restrain the freedom of action of those who buy and sell.

And at a later point the legality of statistical activities was clearly established in the following statement:

We decide only that trade associations or combinations of persons or corporations which openly and fairly gather and disseminate information as to the cost of their product, the volume of production, the actual prices which the product has brought in past transactions, stocks of merchandise on hand, approximate cost of transportation from the principal point of shipment to the points of consumption as did these defendants and who, as they did, meet and discuss such information and statistics without however reaching or attempting to reach any agreement or any concerted action with respect to prices or production or restraining competition do not thereby engage in unlawful restraint of commerce.

Similarly in the Cement case, the plan was declared to be legal. The same liberal attitude was evident as was expressed in the Maple Flooring case.

In the Sugar case, the plan under consideration was declared to be illegal, although on grounds other than that of statistical reporting. It would appear on the contrary, perhaps, that the use of statistics is actually extended. In this case the court said:

**SPECIFIC FEATURES OF STATISTICAL PROGRAMS**—A consideration of the legality of a particular statistical program hinges largely upon the specific features of the plan

- 1 Degree of publicity
- 2 Closed and past transactions
- 3 Price filing
- 4 Adherence to filed prices
- 5 Disclosure of individual price and production data
- 6 Interpretative comments etc
- 7 Meeting and discussion
- 8 Persuasion or pressure
- 9 Penalties
- 10 Supervisory System

**Degree of Publicity**—By implication the courts appear to stress the importance of publicity as preserving the legality of a plan for making available to purchasers and to the public the information collected and disseminated. In the Maple Flooring case, it was stated

The statistics gathered by the defendant Association are given wide publicity. They are published in trade journals which are read by from 90% to 95% of the persons who purchase the products of Association members. They are sent to the Department of Commerce which publishes a monthly survey of current business. They are forwarded to the Federal Reserve and other banks and are available to anyone at any time desiring to use them.

In the Sugar case, the same stand appears to have been taken. The court did say, however, that "information may be received in relation to the affairs of refiners which may rightly be treated as having a confidential character and in which distributors and purchasers have no proper interest." The safest rule seems to be that except for an unusual situation such as that involving credit data, the greater the publicity the greater the likelihood of the plan's legality.

**Closed and Past Transactions**—In the Maple Flooring case, it appears to have been clearly established that a plan which involved the reporting of detailed information relative to past and closed transaction was legal. The plan in question did not disclose the details of individual transactions or identify the policies of members, but consisted only of abstract statistical summaries.

**Price Filing**—Prior to the Sugar case, filing and dissemination of current and future prices was thought to be illegal. In the Sugar case, however, collection and distribution of such statistics was sanctioned because it had been the established practice in the sugar industry for an announcement of any advance in price to be widely circulated and for the advance to go into effect only if concurred in by all other refiners. The court was careful to limit its decision in this regard to the facts of the case before it. It raises difficulties because its use may so easily lead to price fixing or induce concealed price arrangements.

**Adherence to Filed Prices**—An agreement to adhere to filed prices for a fixed period of time or not to deviate therefrom without prior notice was held unlawful in the Sugar case. Assuming complete disclosure to competitors, it facilitates price leadership and price understandings. It also introduces rigidities into the price structure and would ordinarily be interpreted as lessening competition. A waiting period of

any kind would appear likewise to involve the same considerations and would therefore tend to be unlawful

**Disclosure of Individual Price and Production Data**—Ordinarily, the legitimate objectives of statistical reporting can be achieved without disclosure of names of individuals or specific facts relative to each sale. In the Hardwood and Linseed cases, the fact that the plans did involve disclosure of these details drew the adverse criticism of the court. After the decisions were rendered, these practices were discontinued. However, individual situations may exist where some disclosure is necessary to prevent misrepresentations by buyers as to a seller's bids. Thus in the Cement case the court upheld the legality of members reporting full details of all specific job contracts. In this connection the court said:

Unless the provisions in the contract are waived by the manufacturer, demand for and receipt of such deliveries by the contractor would be a fraud on the manufacturer and in our view the gathering and dissemination of information which will enable sellers to prevent the perpetration of fraud upon them which information they are free to act upon or not as they choose cannot be held to be an unlawful restraint upon commerce, even though in the ordinary course of business most sellers would act on the information and refuse to make deliveries for which they were not legally bound.

Just how far this rule to cover special situations may be extended is however, not entirely clear.

**Interpretative Comments, Advice or Suggestions**—Circulation of interpretative comments, advice or suggestions is likely to be regarded by the courts as an indication of group pressure. This stand was clearly taken in the Hardwood case. Later in the Sugar case, the absence of such comments was cited in support of the plan.

**Meetings and Discussions**—In the Maple Flooring case, the right of association members to "meet and discuss" was established, but it is generally recognized that such discussions must not lead to concerted action or other unlawful purposes. In a consent decree signed by the National Container Association (1940), it was specifically provided that the decree should not limit the rights of defendants as they pertained to meeting for the purpose of discussing such information and statistics without, however, reaching or attempting to reach any agreement or any concerted action with respect to prices or production of such containers.

**Persuasion or Pressure**—Any action on the part of an association to exert pressure upon an individual member to pursue a given course of action would appear to be clearly unlawful. This is made evident in a consent decree involving the National Container Association (1940) and denial of this activity was particularly emphasized.

**Penalties**—Provisions of a penal nature which compel a member under duress of fine, suspension, or expulsion, to conform to group action are almost sure to bring the association activity into the illegal area. The individual discretion of the member must be preserved. Such penalties have been distinctly disapproved in the Linseed case and given further judicial attention in the Maple Flooring case.

**Supervisory System**—Supervising the activities of members has been held to be illegal where as in the Linseed case, it is employed for the purpose of prying into the affairs of a member, to discover whether he has complied with the joint agreement of the membership, or where it operates as a constant threat of exposure.

**Uniform Cost Accounting Methods**—The legal status of uniform cost accounting activities of trade associations depends upon the meaning of the term "uniform cost accounting methods." The statement of the Chamber of Commerce of the United States brings out the important considerations:

Each industry has its peculiar accounting problem just as it has its peculiar problems of production and of distribution. It is quite possible, however, in any one industry to develop accounting techniques that will result in the figuring of costs by the members individually on a comparable basis. In other words those differences in cost between the members of the industry, which are bound to exist, will be due to different efficiencies in management and to economic reasons and not because of a lack of cost knowledge.

From a legal standpoint, the problem of uniform costing cannot be dissociated from the larger problem of concerted price and production activity of the industrial group. It is the relation of uniform cost systems to the general lessening of competition that brings the accounting procedures within the range of judicial review and a judgment of the legal status is thus largely dependent on the purposes to which the uniform cost systems are put. Standing alone there is nothing illegal about a uniform cost accounting plan. Even though in fact certain practices such as price agreements or other concerted actions may be rendered easier by the accounting plan, this still is not enough to make the plan illegal. It is the use to which a plan is put that is the deciding factor.

**Average Costs**—The major legal authority for the uniform cost accounting plan is found in the Maple Flooring case. The issues in this case are interwoven with the general statistical activities, but they are at the same time valuable clues as to the accounting aspects. The Maple Flooring Association made calculations as to the cost of the various dimensions and grades of flooring, based upon information secured from the members, and then distributed the calculations back to member companies. The three principal elements of cost were the cost of raw material, the percentage of waste in converting rough lumber into flooring, and all other manufacturing cost. With respect to raw material costs, these data were obtained by the secretary from the reports of sales actually made by members in the open market. Some five to ten sales constituted the bases for an average calculation of this kind of cost. In the case of the waste percentages, these rates were determined on the basis of test runs made by selected members under direction of the secretary of the association. The data as to other manufacturing costs were secured from members by way of questionnaires. This included information as to labor costs, warehousing, insurance and taxes, interest, selling expense, depreciation, etc. The costs so reported were then totaled and provided the basis for a computation of average costs. In this way estimates could be made of the total aggregate cost per thousand feet of

the different types and grades of flooring. Finally, the aggregate costs were allocated by the association to the several types and grades produced from a given amount of rough lumber and these results were tabulated and distributed among the members.

In this leading case the court, by approving the above plan, removed the doubt which had presumably existed prior to this time relative to the dissemination of average costs. It also established the right to discuss cost information, provided no agreement was reached or attempted or any other concerted action covering prices, production, etc., were taken. The court, however, specifically pointed out that these costs so reported to members should not be made an arbitrary basis for determining cost margin, or sales price. In other words, the individual member was required to exercise his own initiative, discretion and judgment in these matters rather than act according to the dictates of the group.

**Costs and Prices**—The court recognized the possibility of the costs being used for price fixing purposes, but held this fact not enough in itself to make the plan illegal.

It cannot we think be questioned that data as to the average cost of flooring circulated among the members of the Association, when combined with a calculated freight rate which is either exactly or approximately the freight rate from the point of shipment plus an arbitrary percentage of profit could be made the basis of fixing prices or for an agreement for price maintenance which if found to exist would under the decisions of this Court constitute a violation of the Sherman Act. But as we have already said the record is barren of evidence that the published list of costs and the freight rate book have been so used by the present Association.

**Features Making Cost Plan Legal**—After a review of the judicial decisions, the recorded proceedings and expressions of the Federal Trade Commission and the Department of Justice, and other authoritative sources, Kirsh (Trade Associations in Law and Business) lists the following as the major individual features which require attention in appraising the legality of individual uniform cost accounting plans:

- 1 The cost data must be as accurate as practicable, based on the experiences of the members and not colored or distorted by improper inclusions or selections.
- 2 There must be no recommendation, advice, comment or criticism with respect to the amount of any item of cost, rate of profit or selling price to be set by the individual member.
- 3 The cost information must be essentially educational and informative in character and the action of the individual member must not be restricted by group pressure.
- 4 The substance of the cost information should be made generally available to avoid so far as possible the implications of secrecy.
- 5 The cost data must be disseminated in such a manner that information contributed by individual concerns is not identified by name and thus made known to competitors.
- 6 There should be no penal provision compelling group action as distinguished from free and uncontrolled individual discretion with respect to cost, margin or selling price.
- 7 Diastolic supervision which is employed to spy upon the activities of a member to discover whether or not he is conforming with the group plan should be avoided.

The consent decree signed in 1940 in the National Container case (US DC, S.D.N.Y., Civil Action No. 8318) is also of particular im-



portance with respect to legality of uniform cost accounting activities. In this decree defendants were enjoined from engaging in certain activities having to do with the establishment of quotas as between members and the fixing of prices. However the decree is notable in that it specifies certain practices which are not affected by the limitations set forth. With special reference to uniform accounting activities, the decree provides:

Nothing contained in this decree limits the right of said defendants, their successors, members, directors, officers, agents and employees and all persons acting under, through or for them, or any of them, to do or to cooperate in doing any act or to engage in any practice not enjoined by this decree including but not limited to the following:

1. Gathering, auditing and disseminating information as to the cost of manufacture of corrugated and solid fiber containers, the volume of production and shipment, the actual price (or base price derived from actual price) which the product has brought in past transactions, stocks of merchandise and materials on hand, approximate cost of transportation and any other facts pertaining to the condition or operation of the industry, and meeting to discuss such information and statistics without, however, reaching or attempting to reach any agreement or any concerted action with respect to prices or production of such containers.

2. Promoting the application of uniform cost accounting to the manufacturing, estimating and sales policies and practices of manufacturers of such containers.

3. Compiling, publishing, and circulating in the form of a currently revised loose leaf industry manual, handbook or otherwise recommended formulas, methods, systems or procedures and illustrations thereof for the computation of selling prices of such containers without, however, in any such industry manual or handbook, specifying or recommending the selling price to be charged for any such containers, the price to be charged for freight or any manufacturing operation or material used in the manufacture of such containers or rate of profit to be included by any manufacturer in the selling price of any such containers.

4. Compiling, publishing and circulating in any form, current data as to the cost of the materials, operations and other elements that go into the manufacture, sale and delivery of such containers provided however that such cost data shall not consist exclusively of average (or weighted average) costs of two or more manufacturers and that the cost of any individual manufacturer shall not be so identified by name or otherwise in any trade association publication as to be made known to its competitors.

5. Exchanging information as to credit and specific current contracts for the sale of such containers for the sole purpose of avoiding interference with such contracts.

Nothing contained in this decree limits the right of a defendant to issue and circulate lists of current prices charged for its corrugated or solid fiber containers, provided such lists are made available to the trade and competitors.

The general conclusion is that legality of uniform cost accounting plans is clearly established. It is only when costing activities are used as a means of controlling prices or production of the individual members that the plan becomes illegal.

## SECTION 25

### STATISTICAL AND MATHEMATICAL METHODS

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## SECTION 25

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# STATISTICAL AND MATHEMATICAL METHODS

### Numerical Presentation of Statistical Data

**FORM OF PRESENTATION**—The form of presentation of statistical data is a major problem, because information, unless properly treated, tends to be confusing and does not lend itself to the drawing of accurate conclusions. Thus the collection of data is only one step in the presentation of statistical reports. The other and more difficult step concerns analysis of the information. For purposes of analysis the data may be presented either numerically or pictorially. The choice depends on the type of data, on their susceptibility to refinement, and on the perceptiveness of the individual for whom the data are intended.

**METHODS OF PRESENTING STATISTICAL FIGURES**—Statistical data may be presented in any of the following ways

- 1 Listing of basic data
- 2 Array
- 3 Frequency distribution

**Listing of Basic Data**—The simplest form of presentation is listing the basic or raw data. Such listing is the easiest to prepare but, where the data are at all extensive, they are hard to comprehend because of the lack of summarization. Fig 1 (Part A) shows a simple illustration in which a hundred time trials for a laborer performing a certain job were recorded to the nearest minute. The results of the successive trials are recorded in the order in which they occurred without rearrangement to facilitate understanding or use of the data. A more elaborate list is found in Fig 2. It is taken from data covering the number of packages delivered on six delivery routes over a two-month period and was prepared as a first step in ascertaining the variable need for delivery equipment over a period of time. The mass of data makes both tables difficult to interpret. In Fig 2 it is obvious that fluctuations are extreme, but beyond that no conclusions can be drawn.

A common device for making statistical data more meaningful is to reduce figures to ratios or percentages. In calculating percentages, a base must first be selected. The selection depends on the type of data and the use to which the percentages are to be put. In Fig 3 the data presented in Fig 2 are reduced to ratios using as a base the highest number for each route, that is, the ratios for one route have no relation

to those for other routes. The reason for the selection of the highest number as a base, rather than the average for the period, is that the purpose of the table is to measure the amount of excess capacity that

A Time Trials Recorded in Order as Made	B Time Trials Recorded as an Array	C Time Trials Recorded in a Frequency Dis- tribution
9 8 15 12 9 6 11 6 11 8 8 7 8 10 10 14 16 8 12 7 8 7 7 7 10 11 12 5 10 9 10 9 9 13 8 10 16 11 8 6 11 14 8 17 7 11 12 7 7 12 10 7 6 9 8 10 7 8 7 8 6 8 8 9 8 10 5 7 8 6 7 11 8 8 6 14 8 9 9 9 9 7 9 11 10 13 7 8 9 0 13 7 9 11 10 8 6 11 10 12	5 7 8 9 10 12 5 7 8 9 10 12 6 7 8 9 10 12 6 7 8 9 10 12 6 7 8 9 10 12 6 7 8 9 10 13 6 7 8 9 11 13 6 7 8 9 11 13 6 7 8 9 11 14 6 8 8 9 11 14 7 8 8 9 11 14 7 8 8 10 11 15 7 8 8 10 11 16 7 8 9 10 11 16 7 8 9 10 11 17 7 8 9 10 11 7 8 9 10 12	Minutes Frequency 5 2 6 8 7 16 8 21 9 15 10 12 11 10 12 6 13 3 14 3 15 1 16 2 17 1  Total 100

FIG 1 Numerical Presentation of Data

will exist through most of the period if sufficient equipment is maintained to handle the maximum. Use of the average daily volume as a base would give a wider range of ratios (from 0 to over 100) but would not so clearly emphasize the element of excess capacity. This table is easier to read because the figures themselves are smaller, and because they convey a definite meaning of size.

**Array**—For a better comprehension of the basic data it may be advisable to arrange them in a systematic form according to magnitudes. Such an arrangement by size (i.e., magnitude) of the observed data is called an array. Fig 1 (Part B) shows the same facts as in Part A, arranged in the form of an array.

**Frequency Distribution**—When the array is summarized so as to show the number of items (that is, the frequency) of each magnitude, the exhibit is called a frequency distribution. Fig 1 (Part C) shows a frequency distribution based on the facts of Parts A and B. Note that in a frequency distribution the items, instead of being individually arrayed, are first grouped into convenient classes, called intervals, and these are then arranged in their order of magnitude. When so arranged, the frequency usually falls into a definite pattern depending upon the behavior of the data.

A frequency distribution has the double advantage of reducing the amount of data to be comprehended and of showing readily the fre-

Date	Route Number						Total
	1	2	3	4	5	6	
September							
1	145	190	220	165	114	145	970
2	167	144	198	108	115	116	848
3	252	177	184	170	103	189	1 075
4	157	129	160	151	139	115	851
5	213	134	164	115	110	145	890
7	186	110	90	97	82	84	658
8	168	163	138	122	92	130	813
9	108	158	171	122	159	147	865
10	140	163	145	110	115	129	802
11	94	122	133	100	97	65	641
12	61	84	102	86	80	77	490
14	49	51	50	30	32	44	265
15	105	112	129	87	58	90	581
16	84	100	117	107	57	84	549
17	141	141	133	73	80	108	685
18	521	606	1 003	321	298	907	3 656
19	217	299	432	149	173	628	1 808
21	203	283	231	220	269	185	1 391
22	234	191	156	152	119	145	997
Etc							
October							
7	104	153	136	150	90	105	747
8	122	122	136	123	142	90	744
9	127	158	147	188	67	56	773
10	090	809	1,141	563	333	1 044	4 580
Etc							
21	168	254	209	206	185	176	1 198
22	184	333	219	156	152	162	1 206
23	136	227	258	256	175	150	1 202
24	100	187	141	107	112	202	900
26	153	118	161	98	107	188	825
27	819	658	981	418	425	729	4 030
28	363	354	474	227	258	503	2 239
29	181	250	347	164	170	442	1 590
30	257	205	335	135	192	327	1 451
31	187	256	185	188	159	173	1 148
Totals	10 679	12 416	14 271	6 575	8 512	12 002	68 115

FIG 2 Number of Daily Route Deliveries

quency of occurrence of given amounts. The principal problem in preparing a frequency distribution is that of determining the size of class intervals. Larger intervals make the table more compact, but if they are too large, significant facts may be obscured. Frequency distributions may be prepared from either basic data or from ratios or percentages as illustrated in Figs 4 and 5. Both these frequency distributions are based on the original data in Fig 2. Note in Figs 4 and 5 that by grouping the observed data the relatively heavier concentration of frequencies in some groups as compared with others becomes apparent. The task of computing averages from grouped data also is made easier.

Date	Route Number					
	1	2	3	4	5	6
September	%	%	%	%	%	%
1	18	23	10	29	21	14
2	20	18	17	19	22	11
3	31	22	16	30	10	18
4	19	16	14	27	26	11
5	26	17	14	20	22	14
7	23	14	9	17	15	8
8	21	20	12	22	17	13
9	12	18	15	22	30	14
10	17	20	13	20	22	12
11	11	15	12	18	18	9
12	7	10	0	15	16	7
14	6	6	4	7	6	4
15	13	14	11	15	11	9
16	10	12	10	19	11	8
17	17	17	12	13	36	10
18	64	75	88	57	56	87
19	26	37	38	26	33	60
21	25	35	20	39	51	18
22	29	24	14	27	22	14
Etc						
October						
7	13	10	12	28	17	10
8	14	15	12	22	27	9
9	16	18	13	33	18	6
10	84	100	100	100	64	100
Etc						
21	21	31	18	37	35	17
22	29	41	19	28	20	15
23	17	28	23	45	39	14
24	12	23	12	10	21	25
26	19	15	14	17	20	18
27	100	81	86	74	80	70
28	44	44	42	40	48	54
29	22	31	30	29	33	42
30	31	25	29	24	36	31
31	23	32	16	33	30	17

FIG 3 Ratio of Daily Route Deliveries to Maximum for the Route

Number of Deliveries	Number of Days					
	Route 1	2	3	4	5	6
0-50	1	0	0	1	1	1
51-100	3	2	2	5	12	7
101-150	16	10	12	17	18	20
151-200	18	17	10	17	12	13
201-250	6	6	7	5	2	0
251-300	3	8	2	3	4	1
301-350	0	4	2	2	1	1
351-400	6	6	9	3	3	10
Total days	53	53	53	53	53	53

FIG 4 Frequency Distribution of Daily Delivery Loads

For Each Route 100% = Maximum Daily Load for That Route

Per Cent	Number of Days					
	Route 1	2	3	4	5	6
0- 10	3	2	4	1	1	10
11- 20	27	18	34	12	13	31
21- 30	14	15	0	20	21	1
31- 40	3	10	2	11	8	3
41- 50	3	4	2	4	4	1
51- 60	0	0	0	2	2	1
61- 70	1	0	1	0	2	2
71- 80	0	2	1	1	1	2
81- 90	1	1	2	0	0	1
91-100	1	1	1	2	1	1
Total days	53	53	53	53	53	53

Fig 5 Frequency Distribution of Daily Relative Loads

## Averages

**AVERAGE DEFINED**—In accounting as in allied fields it frequently becomes necessary to determine a single figure which can be

presentation listed above, that is, they can be computed from the raw or original data, from an array, or from a frequency distribution

**MODE**—The mode is that size or value in any group of data which occurs more commonly than any other size or value Stetson (Mathematics of Business) points out that the mode is "the average used in ordinary speech" in such expressions as "the average size of a farm in this neighborhood is 80 acres," meaning by the average size the most common size Fig 1 (Parts B and C) shows clearly that the mode or modal time is 8 minutes, since this time appeared more frequently than any other The mode can, of course, be determined from Fig 1 (Part A), but since the figures are not arranged with a view to obtaining this information readily, it is more difficult to do so In extensive groups of data the mode cannot be determined easily until the data are arranged in a systematic form according to magnitudes Note that the mode is unaffected by either the number or the size of the items which lie above or below it This characteristic insensitvity of the mode makes it a desirable average for some purposes and undesirable for others



**MEDIAN**—The median is the middle item of a series of numbers or values arranged in then order of magnitude. If the number of items is odd the median is a specific item, if the number of items is even, the median may be considered to be either of the two center items or a calculated amount lying halfway between them, depending upon which interpretation would be the more sensible under the circumstances. The median can be determined very easily from data arranged in an array by counting down or up the line of items to one-half their number. To ascertain the median from data arranged in a frequency distribution a cumulative total of the frequencies is made from either end until addition of the next frequency would exceed one half the total number of items. The median is then considered to be one of the items in this class. In the frequency distribution given in Fig. 1 (Part C) the frequencies of the first four groups (2, 8, 16, 21) total 47, and since the next group contains 15 items, it is evident that item number 50 (or 51) lies within that group. Nine minutes would therefore be the median time. Note that the median and the mode do not coincide for the particular data used in this illustration but lie in adjacent classes. In other series the median and mode might coincide or might be still farther apart.

The median is unaffected by the size of the items lying above or below it, but is affected by the number of items above and below it. This fact is one of the considerations in determining which of the two averages to use in any particular application. The median is generally considered erratic and unreliable if the sample is small or if the nature of the data is such that gaps are likely to occur.

**ARITHMETIC AVERAGE OR MEAN**—The arithmetic mean or simple average of a group of figures is the total of the figures divided by the number of items. Thus the average of the seven values \$30, \$87, \$1 65, \$2 48, \$3 20, \$6 70, and \$11 40 is

$$(\$30 + \$87 + \$1\ 65 + \$2\ 48 + \$3\ 20 + \$6\ 70 + \$11\ 40) \div 7, \text{ or } \$3\ 80$$

Unlike the mode and median, which are averages of position, the arithmetic average is a calculated average. The arithmetic average is affected by the magnitude of every item in its group.

**Range of Sample**—The arithmetic average is not significant where the items included cover too extreme a range. For instance, an average of the annual compensations paid to all employees by a concern ranging from \$1,000 to \$100,000 may have little meaning.

**Size of Sample**—The average of a small sample tends to be less representative of an entire lot than that of a large sample. Thus the average daily production of a machine computed from one week's production reports is less representative than the average daily production based on a month's or even a year's figures.

**Homogeneity of Data**—All items included in an average should be homogeneous, that is, should have the same composition or characteristics. This principle is obviously violated if in finding the average salary of a group of employees some of the salaries are stated at so much per week and others at so much per month. Frequently the violation of the rule is not so obvious though the results, unless carefully interpreted, may be just as misleading. For instance, suppose the following averages were made of the sales and price figures for a lumber company for two consecutive months

January			
100 000	ft of Grade 1 at \$30 per 1 000 ft	\$3 000	
150,000	" " 2 " \$21 " "	3 150	
250 000	ft total sales	\$6 150	
Average selling price per 1 000 ft for January			\$24 60
February			
200,000	ft of Grade 1 at \$29 per 1 000 ft	\$5 800	
50 000	" " 2 " \$20 " "	1 000	
250 000	ft total sales	\$6 800	
Average selling price per 1,000 ft for February			\$27 20

Here the advance of \$2 60 in the average selling price per 1 000 feet from \$24 60 in January to \$27 20 in February might very easily be misinterpreted as an increase in the prices of lumber, whereas the truth is that both prices involved have fallen. The averages calculated reflect merely the over-all change (including, that is, both changing prices and the changing composition of the sales).

The average cost of production (that is, the cost per unit of product) is often used as a method for judging operating efficiency of departmental foremen in a manufacturing plant. A comparison of the average cost of production of Jones (\$1 15) and Smith (\$1 35) is presumably valid if both are doing approximately the same kind of work. This might be the case if the comparison is made of, for example, the same operation in different plants owned by the same company. The comparison would, however, violate the homogeneity rule if the two foremen were in two entirely different and unrelated departments. Furthermore, such an over-all comparison might measure several factors other than the foremen's efficiency, for example, different wage levels prevailing in different plants, different methods of distributing service department charges, etc.

As long as it is understood that the comparison measures the effect of all factors, not only of efficiency, it is a valid comparison. Obviously as a practical matter, if averages for the measurement of a foreman's efficiency are desired, all factors which do not reflect his efficiency must be excluded in computing the averages. (For detailed discussion of variances and measurements of efficiency see Section 2.)

**Positive Utility**—Assume the following are the sales by months of a business for two years

	Last Year	This Year
January	(-) \$ 7,430	(-) \$ 7,498
February	(-) 7 370	(-) 8 332
March	(+) 8 542	(-) 9 591
April	(+) 9 657	(+) 11 129
May	(+) 10,320	(+) 12 948
June	(+) 10 400	(+) 13 350
July	(+) 9 510	(+) 11 700
August	(+) 8 670	(+) 10 480
September	(-) 7 585	(+) 9 700
October	(-) 7 415	(-) 7 530
November	(-) 6 400	(-) 6 800
December	(-) 6 691	(-) 7 162
Total sales	\$100 080	\$116 220
Averages (totals - 12)	\$ 8 340	\$ 9 685

If the sole purpose here is to compare the sales of the two years the averages need not have been computed since the totals of the two columns afford an adequate basis for comparing the two years as a whole and the juxtaposition of the sales for corresponding months affords the basis for monthly comparisons. Inspection of the figures, however, reveals that the sales of this business manifest a pronounced seasonal swing. Showing the average month's sales for each year makes possible a much more critical appraisal of this seasonal swing. The plus and minus signs have been inserted at the left of the monthly figures to indicate the relation of each month to the average for its year. This analysis brings out the fact that the "season" was somewhat later this year than last. This is a legitimate and necessary use of the average since the same facts could not easily have been discovered in the basic data.

**MOVING AVERAGE**—A moving average is one in which the simple average of a consecutive number of terms or items is taken then the first item is discarded and the next item of the remaining terms of the series is included the average of this new group is taken and so on the number of items in each group remaining the same. A frequent application of moving averages is found in the case of sales for a twelve-month period for the purpose of smoothing seasonal fluctuations. Thus sales from June of one year to May of the following year, both months inclusive divided by 12, gives the simple average for one year. The next average is obtained by dropping June of the first year and including June of the following year, and so on.

Moving averages are used frequently to smooth out extreme fluctuations of the data. For example the price of crude oil is subject to daily fluctuations. Oil refineries in pricing the crude oil into the manufacturing process use a moving average based on the monthly averages for the preceding six months.

**PROGRESSIVE AVERAGE**—A progressive average is a succession of arithmetical averages each of which includes all terms of the series included in the previous average plus one additional term. It is, in other words, a cumulative average. For example, a business beginning operations on January 1 may at the end of February find the average of its January and February sales, at the end of March it may find the average of the January, February, and March sales, at the end of April it may find the four-month average, and so forth.

An excellent illustration of a progressive average is furnished by the Petroleum Institute of America in connection with its method of inventory valuation on a last-in first-out basis. Under the Petroleum Institute method the cost of sales for the period is determined on the basis of the latest cost of production. However, the cost of production represents a cumulative or progressive average. At the end of April for example, the average cost of production from January through April is determined, in May the average from January through May, etc. A new series is started at the beginning of each year.

**WEIGHTED AVERAGE**—In a strict sense every arithmetical average is a weighted average. In the preceding examples every item was given the same importance as every other item, that is, it was really given a weight of one, though this is usually spoken of as an unweighted average. Under many practical circumstances it is obvious that the

items of a series to be averaged vary in importance in some quantitative way in addition to the importance explicitly given by the figures in the series. Examples of weighted averages in cost accounting are numerous. In the illustration below it is required to apportion the cost of production between hand-made and machine made bricks, in such a way that the hand-made bricks bear a 25% greater charge than machine-made bricks. This is because the hand-made bricks require more time in handling, setting, etc. If the joint cost for all bricks is \$2 000 and 600 000 machine made bricks and 200 000 hand made bricks were set, the cost per 1 000 bricks is distributed on the basis of the following average

$$\begin{array}{rcl} 600 \text{ M} \times 1 & = & 600 \text{ M} \\ 200 \text{ M} \times 1.25 & = & 250 \text{ M} \\ \hline \text{Total} & & 850 \text{ M} \\ \$2\,000 \div 850 & = & \$2\,352.94 \end{array}$$

Thus the weighted average cost per 1 000 bricks is \$2 352.94. Distribution of the joint cost to machine- and hand made bricks is as follows

$$\begin{array}{rcl} \text{Machine made bricks } 600 \times \$2\,352.94 & = & \$1\,411.76 \\ \text{Hand made bricks } 250 \times \$2\,352.94 & = & 598.24 \\ \hline \text{Total cost distributed} & & \$2\,000.00 \end{array}$$

Note that the average cost per 1 000 is obtained not by dividing by 800 000 bricks processed but by weighting the hand made bricks and expressing them in effect as an equivalent number of machine-made bricks.

Another illustration of a weighted average occurs in pricing stores issues where different lots of raw material have been acquired at different prices. In such cases a simple average of prices is usually not considered desirable. For example, item A23 is found in the stores records to exhibit the following transactions

- 1 Purchased 400 units at 50 cents
- 2 Issued 150 units
- 3 Purchased 400 units at 60 cents

The 150 units issued are, of course, priced at 50 cents. The balance on hand after the third transaction is 650 units consisting of 250 units remaining from lot No 1 at 50 cents and 400 units from lot No 2 at 60 cents. If any further stores issues take place at this time and if they are to be priced at the weighted average cost, the computation is as follows

$$\begin{array}{rcl} 250 \times 50 \text{ cents} & = & \$125 \\ 400 \times 60 \text{ " } & = & 240 \\ \hline 650 & & \$365 \\ \$365 \div 650 & = & \$561.54 \end{array}$$

From the example given above it is obvious that the simple average while it may be technically correct, is practically valueless or positively misleading under certain circumstances. Where quantities as well as dollar values are to be considered, weighted averages are far more significant than a simple average.

**AVERAGE FROM A FREQUENCY DISTRIBUTION—**

Closely related to the weighted average is the problem of calculating the average of data presented in a frequency distribution. In this case the number of items in each class is analogous to the weights assigned to the items in the true weighted average. Two methods are available both of which are illustrated below on the basis of the data shown in Fig. 4 for Route 1.

**Long Method**—Here the mid-point ( $m$ ) of each class is multiplied by its frequency ( $f$ ) and the total of the products is divided by the total of the frequencies. Using the symbol  $\Sigma$  (sigma) to indicate "the sum of the" this method may be expressed by the formula

$$\text{Average} = \frac{\Sigma fm}{\Sigma f}$$

Applied to the following frequency distribution this formula gives

$$\text{Average} = \frac{9825}{53} = 185.4 \text{ deliveries}$$

Number of Deliveries	Mid point ( $m$ )	Frequency ( $f$ )	( $fm$ )
0-50	25	1	25
51-100	75	3	225
101-150	125	16	2000
151-200	175	18	3150
201-250	225	6	1350
251-300	275	3	825
301-350	325	0	0
351-400	375	6	2,250
		( $\Sigma f$ ) 53	9 825 ( $\Sigma fm$ )

**Short Method**—In this method some item presumably near the average is selected as an assumed average. In the table below the deviation of the mid-point of each group below or above the assumed average is expressed in class intervals with the appropriate sign in the column headed ( $x$ ). The product of each of these deviations and the corresponding frequency is shown in the ( $fx$ ) column. Next the total of the ( $fx$ ) column is divided by the total frequencies and the quotient multiplied by the class interval size. The result is the correction which, added to (or subtracted from), the assumed average produces the true average.

Using the symbol  $\Sigma$  to indicate "the sum of the," this method may be expressed by the formula

$$\text{True average} = \text{Assumed average} + \left( \frac{\Sigma fx}{\Sigma f} \times \text{Size of class interval} \right)$$

The assumed average is at the mid-point of the class interval selected as containing the average. Applied to the frequency distribution shown below, it is halfway between 150 and 200 or 175.

The true average computed from the above formula is

$$\begin{aligned}\text{True Average} &= 175 + \left(\frac{11}{53} \times 50\right) \\ &= 175 + 10.4 = 185.4 \text{ deliveries}\end{aligned}$$

Number of Deliveries	(m)	Fre- quency (f)	Deviation from As- sumed Average (x)	Frequency Times Deviation (fx)	
0-50	25	1	-3	-3	
51-100	75	3	-2	-6	
101-150	125	16	-1	-16	-25
151-200	175	18	Assumed average		
201-250	225	6	+1	6	
251-300	275	3	+2	6	
301-350	325	0	+3	0	
351-400	375	6	+4	24	+36
		<u>53</u>		<u>24</u>	<u>+11</u>

**SPECIAL AVERAGES**—Under some circumstances it is found advantageous before averaging raw or basic data to exclude certain items or certain ranges of items entirely. For instance if in the time study referred to in Fig 1 there had been two trial operations which took 28 and 35 minutes, the investigator would have been justified in leaving them out of the averages entirely on the assumption that they must have been caused by circumstances so abnormal that they should not be considered at all for the purpose in hand, presumably the setting of time standards. In time study work particularly it is standard procedure for the observer to eliminate both abnormally low and abnormally high time readings in arriving at a **standard time allowance**.

Contrasted to this method of dropping the **extreme items** is the suggestion made by Riggleman and Friesbee (*Business Statistics*) that for certain rough approximations the average of the highest and lowest items may be useful.

In instances where the computation of an arithmetic mean of all items would involve so much work that it could not be used at all and where it is known that the data are not subject to erratic fluctuations the average of extremes serves a very useful purpose. For example the average price of a certain stock on the New York Exchange on a given day should be obtained by dividing the total number of shares sold into the total amount paid for the shares but this is often so great a task that it cannot be done especially if the study involves a large number of sales. If there are no unusual movements, the average of extremes may be accurate enough for the purpose at hand and it may be much better to use this average in connection with a large number of stocks than to use the more refined methods with a smaller number of stocks.

In the setting of operating standards for a trade association it is often found advisable to omit entirely the highest and lowest tenths (deciles) or fourths (quartiles) of the whole array of reporting members and to use as the standard the average of the central eight tenths or central two fourths (i.e., the **interquartile range**). This is on the assumption that the top and bottom tenths or quarters reflect such exceptional operating conditions, good and bad, that they would be worthless as

guides if included in the standard. It is also conceivable that a standard consisting of the average of the upper two thirds or upper one half of all reporting members of a trade association might prove to be a useful incentive standard. Any such editing of the raw data, however, must be recognized as arbitrary. It should be done with extreme caution and with ample provision for full disclosure to any who might be interested in the resulting standard.

**COMPARISON AGAINST STANDARD**—Frequently it is not necessary to obtain an average. More significant results can be obtained by relating the analyzed data to a standard which represents a known degree of performance. For example, Figs. 4 and 5 give the range of fluctuations but do not indicate the amount of equipment actually required on each route. Fig. 6 compares the actual volume with route standards. The standard in each case relates to the performance of one truck and crew and the table clearly indicates when additional trucks are needed, such trucks being idle on low-volume days.

## Graphic Presentation

**ARITHMETIC SCALE LINE GRAPH**—While frequency distributions clearly disclose the wide range of fluctuations, they do not indicate the sequence in which they occur. To portray this readily resort must be had to some form of visual report. The most convenient form is that of an arithmetic scale line graph. This is the most commonly used form of pictorial presentation and shows the data in relation to time. It cannot conveniently be used where many series of data must be plotted except through preparation of multiple charts. Fig. 7 is based on data of Fig. 2. Inspection of this graph quickly discloses that there is a certain rhythm in fluctuations. This fact is not readily apparent in the several forms of numerical presentation. Furthermore, the graph affords a ready comparison of fluctuations in volume of the two routes.

**SEMI-LOGARITHMIC SCALE LINE GRAPH**—In the event that a graphic comparison is to be made for Fig. 2 between one route and the total of all routes, the arithmetic scale line graph could again be used, plotting two lines instead of one. However, wide differences in volume data for one route and for the total of all routes would make it very difficult to plot all data on a convenient sized chart. For this purpose a logarithmic graph is desirable. Its purpose is to exhibit percentage relationships instead of absolute changes. In Fig. 8 are plotted the relative changes of Route 6 and the total of all routes for a 53-day period.

**BAR GRAPH**—A convenient graph for visualizing comparison of absolute sizes of quantities is the bar graph. Its usefulness is limited by the fact that it cannot readily give expression to the element of time, but it does give a clear comparison of sizes as of a given point in time. Fig. 9 compares total packages delivered for each of six routes for a two-month period. This type of graph combines the advantages of ease of comparison and of preparation, but of course cannot be used to por-

Date		Route Number											
		1		2		3		4		5		6	
		Standard 375		Standard 300		Standard 300		Standard 400		Standard 400		Standard 300	
Exc *	Def *	Exc	Def	Exc	Def	Exc	Def	Exc	Def	Exc	Def	Exc	Def
		230	110		80		235		285		155		
		208	156		102		296		285		184		
		123	123		116		230		297		111		
		218	171		140		249		261		185		
		162	166		136		285		231		155		
		189	190		201		303		318		216		
		207	137		162		278		308		170		
		267	129		139		241		241		153		
		235	137		155		250		285		171		
		281	178		167		300		303		205		
		314	216		198		314		314		223		
		326	249		250		361		368		256		
		270	188		171		313		343		210		
		291	200		183		283		343		216		
		234	159		167		327		311		192		
	146		306	1	703		79		102	607			
		158			132		251		227	328			
	146	3 713	306	2 523	835	2 357	4 682		4 872	955	2 802		
September													
	1												
	2												
	3												
	4												
	5												
	7												
	8												
	9												
	10												
	11												
	12												
	14												
	15												
	16												
	17												
	18												
	19												

Excesses and deficiencies

FIG. 6 Comparison of Volumes with Standards (based on Fig. 2)



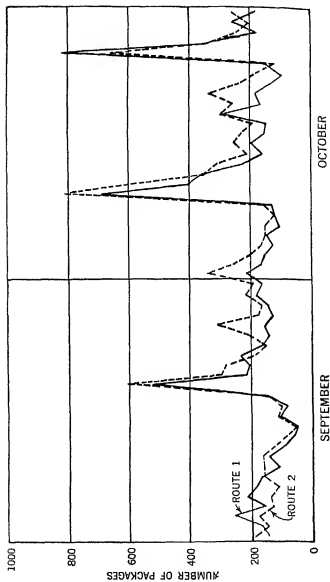
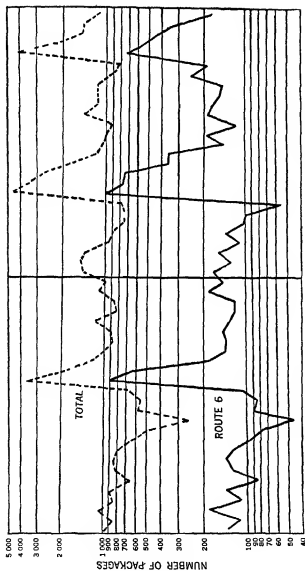


FIG 7 Ordinary Lane Graph (based on Fig 2)



OCTOBER

SEPTEMBER

Fig 8 Lane Graph (plotted on semi logarithmic scale)

tray relative quantities at different points of time except through the use of a series of graphs

**COMPONENT COLUMN GRAPH**—The disadvantage of the bar graph referred to above, that of not giving expression to the time factor, is in part overcome by the component bar graph, since it is possible to portray volume data for several points of time. This graph takes two forms. One compares absolute quantities, the other shows percentage relationships, but does not indicate changes in totals as between several

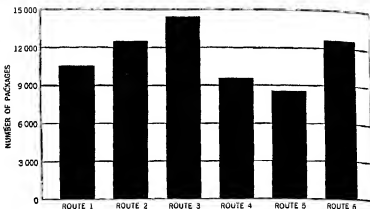


FIG 9 Bar Graph

points of time. The choice between the two forms depends upon the purpose of presentation. The first form emphasizes fluctuations in total volume, but comparison of components is at times difficult. The second form does not portray changes in totals, but does show clearly changes in components. Both types are illustrated below showing the changes in deliveries for six routes at six different points of time (Figs 10 and 11).

**CORRELATION OR DOT GRAPH**—Correlation graphs are useful in portraying the relationship in changes in two given series of data. In the field of job evaluation, for example, the graph is a convenient device for determining, by inspection, whether or not a given wage structure is sound. The horizontal scale (Fig 12) designates hourly rates of pay and the vertical scale designates occupation scores. If the intervals on each scale are equal, then all points designating wage rates for given job scores must fall on a straight line. The procedure in preparing the graph is first to plot the points for standard rates and then to plot the points representing actual rates. Any great divergence from the straight line indicates a lack of proper evaluation. The data on page 1393 are plotted on the graph shown in Fig 12. Inspection reveals the extent to which the actual wage scale departs from standard.

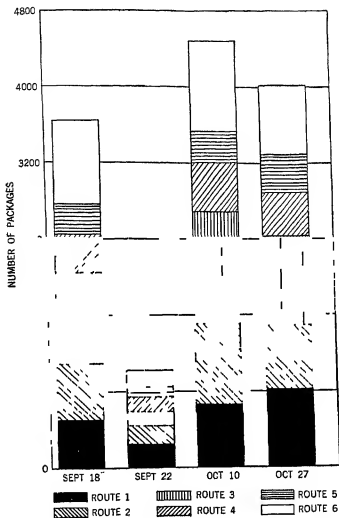


FIG 10 Component Column Graph

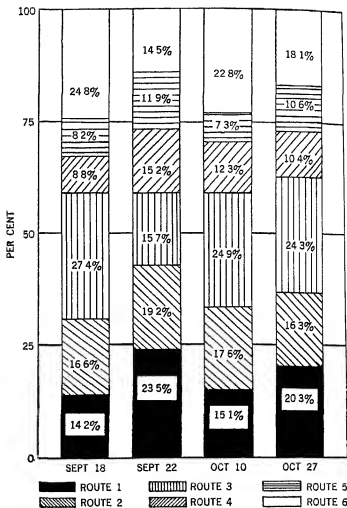


Fig 11 Component Column Graph (on percentage basis)

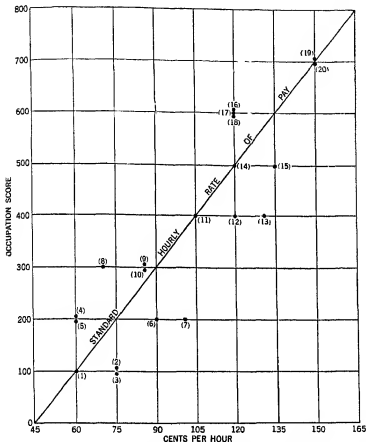


FIG 12 Variations of Actual from Standard Wage Scale

Occupation Scores	Standard Hourly Rate of Pay	Actual Hourly Rates of Pay (Twenty Employees)					
100	\$ 60	(1)	\$ 60	(2)	\$ 75	(3)	\$ 75
200	75	(4)	80	(5)	80	(6)	90
300	90	(7)	1 00	(8)	70	(9)	80
400	1 05	(10)	80	(11)	1 05	(12)	1 20
500	1 20	(13)	1 30	(14)	1 20	(15)	1 35
600	1 35	(16)	1 20	(17)	1 20	(18)	1 20
700	1 50	(19)	1 50	(20)	1 50		

**GANTT CHARTS**—The Gantt chart is a device originated by the late Henry L. Gantt for the purpose of graphically planning work, and on the same record showing the degree of accomplishment of the plan (in terms of time or the amount of work converted into time relation ship). According to Clark (*The Gantt Chart*), a division of space on the chart represents both an amount of time and an amount of work to be done in that time. Lines drawn horizontally to scale through that space show the relation of the amount of work actually done in that time to the amount scheduled. Equal divisions of space on a single horizontal line may therefore represent

- 1 Equal divisions of time
- 2 Varying amounts of work scheduled
- 3 Varying amounts of work done

**Classes of Gantt Charts**—The principle of the Gantt chart can be applied to any human activity, but it has been applied most extensively to industrial production. Even in that field there are great possibilities for its further application. The Gantt charts fall into three general classes

- 1 Man and Machine Record Charts
- 2 Layout and Load Charts
- 3 Progress Charts

In the **man and machine record charts**, Gantt provides a mechanism to show the relation between what is done and what could be done by a man or a machine. The gap between actual and possible accomplishment is idleness; that is, the neglect to make full use of the man power or equipment available.

The reasons for idleness, which are emphasized by the **man and machine record charts**, indicate that steps must be taken some time in advance in order to avoid idleness. The **machine layout chart** is Gantt's mechanism to plan work so as to avoid idleness of men and equipment and to get work done in the order of its importance. The **machine load chart** shows the amount of work, in hours or days ahead of a plant or any part of a plant. (For detailed discussion of Gantt charts, especially layout and load charts, see *Production Engineers' Handbook*, edited by Alfred and Bangs.)

Through use of such charts **idle capacity costs** may be segregated and shown separately in the Profit and Loss statement. This segregation calls attention to an item that otherwise is merged in general overhead. Translation of idle hours into dollars forces responsible executives to take action.

**Man Record Chart**—Fig. 13, taken from Clark, is a Gantt chart for measuring labor performance. The width of each daily space represents the standard task for that day and is therefore equal to 100%. Since tasks for successive days may vary, the numerical value of each day's space may differ. Light lines show actual production, heavy lines cumulative production. Thus on October 21 if the standard production of Operator 38 was 400 units, and the actual production was 300 units his accomplishment is therefore equal to 75% of the day's standard, and a light line is drawn through 75% of the space. On the same day Operator 109 produced 225 units against a standard of 200. This is equal to 112.5%

of standard. The light line therefore extends through the entire space, the extra 12.5% being shown as a short line equal to one half of a division directly above the 100% line thus



At the end of the week a doubling back of the heavy line indicates that the worker exceeded standard for example, Operator 97. The portion of a daily space through which no line is drawn shows the extent of the worker's failure to meet the standard set. Reasons for failure are indicated by symbols

- A - Absent or late
- G - Green operator
- I - Lack of instructions
- L - Slow operator
- M - Material troubles
- R - Repairs needed
- T - Tool troubles or waiting for tools
- V - Holiday
- Y - Smaller lot than estimate is based on

Similar charts summarizing results by departments are prepared in the office. It is also possible to prepare summaries for each department.

**Progress Chart**—The purpose of the Gantt progress chart is to show what progress is being made in the execution of a plan or program. The width of the daily space represents the standard task or schedule, rather than time. This is because spaces on the chart representing time can be translated into work units or dollar amounts that can be produced in that time. This chart may be used for controlling production, sales, office work, budgeted expenses, etc. Applications of Gantt progress charts to the analysis of costs are shown in Figs. 14 and 15 taken from Boyan (Handbook of War Production). Fig. 14 and the accompanying statistical table present the following facts:

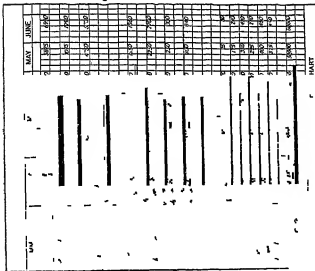
1. Total factory overhead, actual and applied, and administrative overhead.
2. Actual and applied overhead and budget for each department.

Boyan states:

The production in machine hours for machine shop No. 1 is indicated. In the example, the estimates were based on the assumption that the department would operate 10,000 machine hours per month. Actually, for the three-month period, it operated 140% above the 10,000 machine hours monthly standard.







ANALYSIS OF OVERHEAD TOTALS FOR THE QUARTER

F	Actual	Appt of	Cost variance		Net variance
			Deb 1	Credit	Deb 1 Credit
Factory overhead	215,500	215,500	42,200		42,200
Administration	64,500	64,500			
Total	280,000	280,000	42,200		42,200
By departments:					
Machine shop 1	92,000	92,000	12,600		12,600
Machine shop 2	135,000	135,000	9,000		9,000
Heat treating	15,000	15,000	500		500
Assemble	42,200	42,200	1,100		1,100
Total	286,200	286,200	23,200		23,200

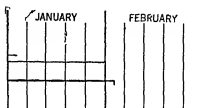
Cost variance: The difference between an actual overhead and a F budget for overhead

Volume variance: The difference between the amount of overhead applied in a basis and F budget for overhead

Net variance: The difference between the amount of overhead applied in a basis to the actual and the amount of actual overhead over or under absorbed thereby

Progress Chart Graphical Analysis of Overhead

The estimated budget for each month is indicated by the small figures at the left of each monthly space. Figures at the right of each monthly space indicate cumulative amounts. Actual expense for January was \$35,650 or 115% of the budgeted amount. Since each subdivision of a monthly space represents 20%, the light line for actual expense is drawn through the entire space plus three-fourths of a subdivision.



The cumulative heavy line for January extends straight across 5% subdivisions, thus reaching into the February space, a small vertical line showing the end of the January total.

Applied overhead for January is taken from the production orders is \$48,500 or 150% of the budget. Both the monthly figures and the cumulative figures for applied expenses are plotted in light lines. An analysis of actual expenses by expense components is shown in the lower part of Fig 14. According to Boyan.

By a comparison of the ratios of the lines it is possible to discern the points at which executive attention should be concentrated and to determine whether the variances are due to inefficient operation or to incorrect rates. As an example, machine shop No 1 had a heavy repair charge for January against production attained, and therefore the actual overhead incurred by this department was increased considerably by this charge.

The same author presents Fig 15 and accompanying statistical data to show a comparison of actual and estimated costs on specific production orders, which are parts of one contract. They are analyzed according to their cost elements, i.e., material, labor, applied expense by departments, and special direct charges. The number of units scheduled and completed is shown at the bottom of the chart. Estimated costs on each order are computed by multiplying the units completed by their estimated unit cost. On production order No 1 actual material costs are 131.5% of estimate, which is shown by a light line. Heavy lines indicate cumulative results on the two production orders completed to date. Note that the heavy line is not the sum of the two light lines, since the chart space allotted to each order had different numerical values. For direct material actual cost on the two orders is 137% in excess of the estimate (\$28,600 - \$25,160).

Other valuable information may be secured through these charts. Says Boyan.

A more complete picture would be presented by summarizing all the production orders finished during the period. This involves no special work in



process valuation, only a tabulation of the cost and estimate comparisons for each contract. Such a tabulation serves as a useful supplement to the regular manufacturing and profit and loss statements.

Regardless of the specific method employed the following general procedure may be used at the end of a month or a quarter to analyze the cost and profit position of the company in terms of its current contracts:

- 1 Preparation of cost and estimate comparisons for each contract in progress or completed during the period
- 2 Inspection of the differences between costs and estimates
- 3 Review of profit margins on completed contracts and the probable profit margins on contracts in progress
- 4 Analysis of the differences between applied and actual overhead for the departments to see if profit margins are being offset by excesses in variable overhead

### Fundamental Arithmetical Operations

**ADDITION**—If addition is performed mentally only the sums of addends should be thought (spoken internally) as the eye travels from one digit to another in the column. For example, in adding the column

9  
7  
3  
5

downward, the computer should think 16, 19, 24 only. Set down 4 and carry 2 to the next column. Further speed in addition is obtained by grouping figures, particularly, by learning to add figures in pairs. Thus in the above case, the computer merely adds 16 (i.e., 9 + 7) + 8 (i.e., 3 + 5).

**Bookkeeper's Check for Addition.**—After the addition is completed, it is checked by adding each column separately without carrying to the next higher column. Distribute the result of each column addition under units, tens, hundreds, etc., to the right of the problem as follows:

	T	H	T	U	D	¢
\$ 275 62					1	7
3 517 86				3	8	
450 92			2	5		
65 50		2	8			
87 45	1	3				
211 62	3					
\$4 608 97	4	6	0	8	9	7

In the left hand portion, the sum is found in the conventional manner. It is checked by adding the cents column (17 cents, or 1 dime and 7 cents). The dime column adds 38 dimes, or \$3 in unit column + 8 dimes. The first column left of the decimal point adds to \$25. It is distributed as 2 under tens and 5 under units.

**Use of Adding Machines.**—To check the sum, if the machine is a listing machine, compare the items added (addends) with those on the machine list. If the items agree, the machine total is correct. If the machine is nonlisting, make a record of the sum shown on the dial, then add again in reverse order, i.e., from last item to first. If the new sum shown in the dial agrees with the first, the sum is correct.

**SUBTRACTION**—The most effective method of performing subtraction is by the "making change" or Austrian method. Thus instead of subtracting 3 from 8, the computer thinks, 3 plus 5 equals 8, and writes the difference as 5

\$147 36	Minuend
68 22	Subtrahend
<u>\$ 79 14</u>	Difference

In the example above, the operation, column by column, is as follows: Starting with the cents column instead of saying 6 minus 2 is 4 say 2 plus 4 equals 6 put down 4. Next, 2 plus 1 = 3 put down 1, then 8 plus 9 = 17, put down 7 and carry 1. Finally 1 (carried) + 6 = 7 plus 7 = 14. In each case enough is added to the subtrahend to produce the number in the minuend. To prove the answer, add the remainder to the subtrahend. The result equals the minuend if the work is correct.

**Balancing Accounts**—It is not necessary to foot both sides of the account and then subtract one from the other to obtain the balance. Instead the Austrian method of subtraction is used. In the example below, the cash balance of \$12,573 81 is found as follows:

Dr			CASH	Cr			
Mar	1	Balance	\$ 6 304 98	Mar	31	Disbursements	\$18 530 01
	31	Receipts	17 231 54	Apr	30	"	12 006 53
Apr	30		18 459 63	May	31	"	15 748 22
May	31	"	14 586 77	June	30	"	10 357 18
June	30	"	12 641 83		30	Balance	12 573 81
			<u>\$69 224 75</u>				<u>\$69 224 75</u>

Foot the debit side of the account, the total is \$69,224 75, write this total on the credit side. Then add the credit side and add enough to each column of digits to produce the desired total thus in the unit cents column  $1 + 3 + 2 + 8 = 14$ , plus 1 = 15. A 5 is required in the answer in the unit column, hence 1 must be added to the 14 to produce that 5. On the line reserved for the balance put down 1 and carry 1. In the 10's column add 1 (carried) + 5 + 2 + 1 which equals 9, plus 8 = 17, put down 7 and carry 1, etc. In this way two additions provide the answer, in place of two additions and one subtraction.

**Combined Addition and Subtraction**—Frequently accountants have to add long columns of figures containing both red and black ink figures. It is not necessary to add each type separately and then get the difference. Instead, figures may be added in a single operation. In the example below, proceed as follows:

\$ 227 86
430 30
774 54
236 52*
397 50
712 34*
492 30
905 81
409 43*
<u>\$1 870 11</u>

\* Red

Starting at the top of the unit column, add  $6 + 4 = 10$ , minus  $2 = 8$  minus  $4 = 4$ , plus  $9 + 1 = 14$  minus  $3 = 11$ . Put down 1 and carry 1. In the same way the other columns are added. Whenever a red ink figure is met, it is subtracted, and the addition then continued with the black ink figures.

**MULTIPLICATION**—Short-cuts that have proved of service in multiplying are

- 1 Moving the decimal point
- 2 Aliquot part multiplying
- 3 Distributive law multiplying
- 4 Left to right multiplying to avoid unnecessary handling of decimals

#### Moving the Decimal Point—

- 1 To multiply a number by 10, move the decimal point one place to the right

Example  $27.42 \times 10 = 274.2$

- 2 To multiply a number by 100, move the decimal point two places to the right

Example  $287.56 \times 100 = \$28,756.00$

- 3 In general, if the multiplier is 1 followed by any number of zeros move the decimal point to the right as many places as there are zeros in the multiplier

Example  $287.359 \times 10,000 = 2,873,590$

- 4 To multiply a number by 1 01 001 etc. move the decimal point to the left in the number as many places as there are in the decimal multiplier

Examples  $756 \times 1 = 756$

$6857 \times 0001 = 6857$

$19876 \times 001 = 0019876$

To multiply a number by .03 move the decimal point two places to the left and then multiply by 3

Example  $475 \times .03 = 0475 \times 3 = 1425$

**Aliquot Part Multiplication**—Aliquot parts are of great help in performing many types of multiplication. A number which is contained in 10 or powers of 10 an even number of times is called an aliquot part of 10 or of the corresponding power of 10. Thus 25 being contained in 100 four times is  $1/4$  of 100, 62.5 is  $1/16$  of 1,000  $3\frac{1}{3}$  is  $1/3$  of 10. The fractions  $1/4$ ,  $1/16$ ,  $1/3$ , etc., are called aliquot fractions. As stated by Schlauch and Lang (Mathematics of Business and Finance)

It is to be noted that the fractional equivalents of the aliquot parts have unity for their numerator and for their denominator a figure equal to the number of times that the aliquot part is contained in the given number.

When one of two numbers to be multiplied is an aliquot part of some power of 10, it is easier to multiply by that power of 10 and then multiply by the aliquot fraction.

- 1 To multiply 804 by 25 multiply by 100 and take  $\frac{1}{4}$

$1/4 \times 80,400 = 20,100$

- 2 To multiply 726.84 by 125, multiply by 1,000 and take  $\frac{1}{8}$

$1/8 \times 726,840 = 90,855$

- 3 To multiply 35 876 by 625, multiply by 10,000 and take  $1/16$

$$1/16 \times 358,760 = 22,422.5$$

If multiplication by  $1/16$  or division by 16 seems difficult take  $\frac{1}{4}$  of  $\frac{1}{4}$ , i.e.

$$1/16 \times 358,760 = 1/4 \times 89,690 = 22,422.5$$

Fig 16a presents a list of useful aliquot parts that may be used to shorten multiplication and division (see discussion later in this Section) The illustrations below show how the table is used

- 1  $16\% \times \$14239 = 1/6 \times \$14239 = \$2373$  Locate 16% in Fig 16a, at the head of the column appears the number 100 at the extreme left the fraction  $1/6$  Hence 16% is  $1/6$  of 100, move the decimal point to the right two places and divide by 6
- 2  $833\frac{1}{3}\% \times \$6238 = 1/12 \times 6238 = \$519.8$  833 $\frac{1}{3}\%$  is  $1/12$  of 10,000 hence move the decimal point four places to the right and divide by 12
- 3  $5/8 \times 18434 = 10/16 \times 18434 = 1/16 \times 18434 = 1152.1$

Fraction	Parts of			
	10	100	1000	10000
$1/2$	5	50	500	5000
$1/3$	$3\frac{1}{3}$	$33\frac{1}{3}$	$333\frac{1}{3}$	$3333\frac{1}{3}$
$1/4$	25	25	250	2500
$1/5$	2	20	200	2000
$1/6$	$12\frac{2}{3}$	$16\frac{2}{3}$	$166\frac{2}{3}$	$1666\frac{2}{3}$
$1/8$	125	125	125	1250
$1/10$	1	10	100	1000
$1/12$	$83\frac{1}{3}$	$8\frac{1}{3}$	$83\frac{1}{3}$	$833\frac{1}{3}$
$1/15$	$66\frac{2}{3}$	$6\frac{2}{3}$	$66\frac{2}{3}$	$666\frac{2}{3}$
$1/16$	625	625	625	625
$1/20$	5	5	50	500
$1/25$	4	4	40	400

FIG 16a Aliquot Parts

Factor	Ratio	Factor	Ratio
75	10 $-1/4$ of 10	1875	25 $-1/4$ of 25
875	10 $-1/8$ of 10	225	25 $-1/10$ of 25
1125	10 $+1/8$ of 10	$23\frac{1}{3}$	20 $+1/6$ of 20
115	$12\frac{1}{2}-1$	2375	25 $-1/20$ of 25
$13\frac{1}{3}$	10 $+1/3$ of 10	$26\frac{2}{3}$	$16\frac{2}{3}+10$
135	$12\frac{1}{2}+1$	275	25 $+1/10$ of 25
1375	$12\frac{1}{2}+1/10$ of $12\frac{1}{2}$	3125	25 $+1/4$ of 25
175	20 $-1/8$ of 20	375	25 $-1/2$ of 25
18	20 $-1/10$ of 20	$41\frac{2}{3}$	$33\frac{1}{3}+1/4$ of $33\frac{1}{3}$

FIG 16b Quasi Aliquot Parts



**Quasi Aliquot Parts**—Frequently it is required to multiply by numbers that are not aliquot parts of powers of 10 but which can be broken up into two or more numbers, each of which is an aliquot part of 10, 100, etc. or of each other. This is sometimes referred to as the **distributive law of multiplication**, i.e., instead of multiplying one number by another, the first number is multiplied by each of the parts into which the second was analyzed. Fig. 16b shows some of these numbers with suggestions for their handling. The following examples illustrate the use of this method.

- 1  $84,628 \times 135 = 84,628 \times (125 + 10)$   
 $84,628 \times 125 = \frac{1}{8} \times 84,628 = 10,578.5$   
 $84,628 \times 10 = 846,280$   
 Product  $= 11,424.78$
- 2  $\$450.75 \times 256\frac{1}{4} = \$450.75 \times (250 + 6\frac{1}{4})$   
 $450.75 \times 250 = \$112,687.50$  ( $250 = \frac{1}{4}$  of 1,000)  
 $450.75 \times 6\frac{1}{4} = 2,817.19$  ( $6\frac{1}{4} = 1/16$  of 100)  
 Product  $= \$115,504.69$
- 3  $1,382.41 \times 37.5 = 1,382.41 \times (25 + 12\frac{1}{2})$   
 $1,382.41 \times 25 = 34,560.25$  ( $25 = \frac{1}{4}$  of 100)  
 $1,382.41 \times 12\frac{1}{2} = 17,280.125$  ( $12\frac{1}{2} = \frac{1}{8}$  of 100)  
 Product  $= 51,840.375$

In this problem multiplication by  $12\frac{1}{2}$  is accomplished by taking  $\frac{1}{8}$  of 34.56. This is of course easier than taking  $\frac{1}{8}$  of 138.241.

When the method has been well learned the analysis shown above is omitted, and only the products of each term by its multiplier are set down and added. Thus,  $1,458 \times 725$ , or  $1,458 \times (125 + 500 + 100)$  is computed

$$\begin{array}{r} 182,250 \\ 729,000 \\ 145,800 \\ \hline 1,057,050 \end{array}$$

If desired, the above multiplication can be reduced to two factors, thus

$$\begin{array}{r} 1,458 \times 725 = 1,458 \times (625 + 100) \\ \begin{array}{r} 911,250 \\ 145,800 \\ \hline 1,057,050 \end{array} \end{array}$$

**Check for Multiplying**—The most useful check for the accuracy of a product is to reverse the process. The procedure is: Divide the product obtained by one of the numbers used as factors. The quotient must be the other factor, if the result is correct.

**Left to Right Multiplication**—Many business calculations involve multiplication of numbers containing many decimals. Suppose  $\$4,321.9424$  is to be multiplied by 672.38. This would mean nine decimals to be pointed off in the answer. Since accuracy is required only to the nearest cent, this means a useless expenditure of energy, since 6 or 7 places are dropped in the final answer. Left to right multiplication offers a convenient means of carrying only enough decimals to insure accuracy to the nearest cent in the product. In this type of multiplication the mul-

tplier is broken up into its component parts, that is, 672 38 becomes  $600 + 70 + 2 + 3 + 08$ . In the example below, the product is obtained by the conventional method while alongside the left to right multiplication is shown

Multiply \$4 3219424 by 672 38		Left to Right	
Conventional Method			
$  \begin{array}{r}  \$4\ 3219424 \\  \times \quad 672\ 38 \\  \hline  345755392 \\  129658272 \\  86438848 \\  302535968 \\  259316544 \\  \hline  \$2905\ 987630912 \\  \hline  \underline{\underline{\$2\ 905\ 99}}  \end{array}  $		$  \begin{array}{r}  \$4\ 32\ 19424 \times 672\ 38 \\  \hline  2593\ 1652\ 432\ 1942 \times 600 \\  302\ 5358\ 43\ 2194 \times 70 \\  8\ 6438\ 4\ 3219 \times 2 \\  1\ 2963\ 4321 \times 3 \\  \hline  3456\ 0432 \times 8 \\  \hline  2905\ 9867 \\  \hline  \underline{\underline{\$2\ 905\ 99}}  \end{array}  $	

The figures for the left to right multiplication are obtained as follows. Multiplying by 600 consists of multiplying by 100 and then by 6. The former is effected by moving the decimal point two places to the right. Hence count two places and draw a vertical line to mark the location of the decimal point in the answer as well as in the partial products. Now count four digits to the right of the vertical line and cross off any excess digits (in this case the last digit 4). Multiply in the usual way.

Next multiply by 70 (i.e.,  $10 \times 7$ ). Hence move the original decimal point mentally one place to the right and count four digits to the right crossing off the excess digit (i.e., the digit 2), then multiply as usual. Actually it is not necessary to move the decimal mentally and count four places, it is merely necessary with each new multiplier to cross off an additional digit at the right.

The other partial products are handled similarly to those above, and added after all multiplications have been performed. Carrying four places for the partial products insures accuracy to the nearest cent.

**Aliquot Parts Combined with Left to Right Multiplication**—Further time savings are possible by the use of aliquot parts in combination with left to right multiplication.

1	$  \begin{array}{r}  \$3125\ 25 \times 023\ 7842\cancel{3} \\  \hline  71\ 3526 \\  2\ 9730 \\  \hline  6050 \\  \hline  \$74\ 33\cancel{2}6  \end{array}  $	Multiply by 3000 " " 125 (1/8 of 1,000) " " 25 (1/4)
2	$  \begin{array}{r}  \$62\ 51 \times 9\ 422\ 7003 \\  \hline  588\ 0193 \\  \hline  0042 \\  \hline  \$589\ 01\cancel{3}5  \end{array}  $	Multiply by 62 5 (1/16 of 1 000) " " 01
3	$  \begin{array}{r}  \$6\ 18\ 273\cancel{6}4 \times 793 \\  \hline  4946\ 1888 \\  43\ 2789* \\  \hline  4902\ 9099 = \underline{\underline{\$4\ 902\ 91}}  \end{array}  $	Multiply by 800 " " 7 and subtract

\* Red

**DIVISION**—Several methods of shortening operations involving division may be used. These are

- 1 Division by aliquot parts of 10 etc
- 2 Division through multiplication by reciprocals
- 3 Long division continental method
- 4 Long division by successive elimination of digits in divisor

**Division by Aliquot Parts**—In the first example below division by 12.5 is accomplished by first dividing by 100, then multiplying by 8. The same method is used for the other examples, the necessary information in each case being obtained from Fig. 16

$$1 \quad 4872 - 12.5 = 4872 \times 8 = \underline{\underline{38976}}$$

$$2 \quad \$456.89 - 100\% = \$456.89 \times 6 = \underline{\underline{\$2741.34}}$$

$$3 \quad 567.45 \div 25 = 567.45 \times 4 = 22698$$

These illustrations point to the following rule which applies to true aliquot parts as well as to quasi-aliquot parts. To divide by an aliquot part, divide by the basic power of 10, and then multiply by the aliquot fraction inverted.

**Division Through Multiplication by Reciprocal**—Division may be performed by multiplying by the reciprocal

$$a \div b = a \times \frac{1}{b}$$

The advantages of the reciprocal method are (Schlauch and Lang, *Mathematics of Business and Finance*)

- 1 Multiplication is easier than division and less subject to error
- 2 Prepared tables of reciprocals are available
- 3 Use of left to right multiplication is made possible

12 182 57 - 4 357		
= 12 182 57 ×	2295	157
	2295	1570
	459	0314
	22	9516
	18	3608
		5738
		154
		<u>2796 0998</u>
		Multiplication by
		10000
		2000
		100
		80
		25 (¼ of 10)
		07

Fig. 17 is a page taken from Lang and Schlauch (*Selected Tables*). These tables contain the reciprocals of all numbers from 1 to 10,000. Thus in the above problem it was necessary to look for the reciprocal of 4357. The number actually looked up was 4357 and an adjustment was made to compensate for the shifting of the decimal point. The rule may be stated as follows: Moving the decimal point in the number column to the right, shifts the decimal point in the reciprocal column an equal number of places to the left, and vice versa.

Number	Reciprocal
4357	0002295157
435.7	002295157
43.57	2295157
004357	229.5157
435700	000002295157

No Recpl	No Recpl	No Recpl	No Recpl	No Recpl
000	000	000	000	000
4251 2352388	4301 2325041	4351 2298322	4401 2272211	4451 2246886
4252 2351834	4302 2324500	4352 2297794	4402 2271695	4452 2246181
4253 2351281	4303 2323980	4353 2297266	4403 2271179	4453 2245677
4254 2350729	4304 2323420	4354 2296739	4404 2270663	4454 2245173
4255 2350176	4305 2322880	4355 2296211	4405 2270148	4455 2244669
4256 2349624	4306 2322341	4356 2295684	4406 2269632	4456 2244165
4257 2349072	4307 2321802	4357 2295157	4407 2269117	4457 2243662
4258 2348520	4308 2321263	4358 2294631	4408 2268603	4458 2243158
4259 2347969	4309 2320724	4359 2294104	4409 2268088	4459 2242655
4260 2347418	4310 2320186	4360 2293578	4410 2267574	4460 2242152
4261 2346867	4311 2319647	4361 2293052	4411 2267060	4461 2241650
4262 2346316	4312 2319109	4362 2292526	4412 2266546	4462 2241147
4263 2345766	4313 2318572	4363 2292001	4413 2266032	4463 2240645
4264 2345216	4314 2318034	4364 2291476	4414 2265519	4464 2240143
4265 2344666	4315 2317497	4365 2290951	4415 2265006	4465 2239642
4266 2344116	4316 2316960	4366 2290426	4416 2264493	4466 2239140
4267 2343567	4317 2316423	4367 2289902	4417 2263980	4467 2238639
4268 2343018	4318 2315887	4368 2289377	4418 2263468	4468 2238138
4269 2342469	4319 2315351	4369 2288853	4419 2262955	4469 2237637
4270 2341920	4320 2314815	4370 2288330	4420 2262443	4470 2237136
4271 2341372	4321 2314279	4371 2287806	4421 2261932	4471 2236636
4272 2340824	4322 2313744	4372 2287283	4422 2261420	4472 2236136
4273 2340276	4323 2313208	4373 2286760	4423 2260909	4473 2235636
4274 2339729	4324 2312673	4374 2286237	4424 2260398	4474 2235136
4275 2339181	4325 2312139	4375 2285714	4425 2259887	4475 2234637
4276 2338634	4326 2311604	4376 2285192	4426 2259376	4476 2234138
4277 2338087	4327 2311070	4377 2284670	4427 2258866	4477 2233639
4278 2337541	4328 2310536	4378 2284148	4428 2258356	4478 2233140
4279 2336995	4329 2310002	4379 2283626	4429 2257846	4479 2232641
4280 2336449	4330 2309469	4380 2283105	4430 2257336	4480 2232143
4281 2335903	4331 2308936	4381 2282584	4431 2256827	4481 2231645
4282 2335357	4332 2308403	4382 2282063	4432 2256318	4482 2231147
4283 2334812	4333 2307870	4383 2281542	4433 2255809	4483 2230649
4284 2334267	4334 2307337	4384 2281022	4434 2255300	4484 2230152
4285 2333722	4335 2306805	4385 2280502	4435 2254791	4485 2229654
4286 2333178	4336 2306273	4386 2279982	4436 2254283	4486 2229157
4287 2332634	4337 2305741	4387 2279462	4437 2253775	4487 2228661
4288 2332090	4338 2305210	4388 2278943	4438 2253267	4488 2228164
4289 2331546	4339 2304678	4389 2278423	4439 2252760	4489 2227668
4290 2331002	4340 2304147	4390 2277904	4440 2252252	4490 2227171
4291 2330459	4341 2303617	4391 2277386	4441 2251745	4491 2226676
4292 2329916	4342 2303086	4392 2276867	4442 2251238	4492 2226180
4293 2329373	4343 2302556	4393 2276349	4443 2250731	4493 2225684
4294 2328831	4344 2302026	4394 2275831	4444 2250225	4494 2225189
4295 2328289	4345 2301496	4395 2275313	4445 2249719	4495 2224694
4296 2327747	4346 2300966	4396 2274796	4446 2249213	4496 2224199
4297 2327205	4347 2300437	4397 2274278	4447 2248707	4497 2223705
4298 2326664	4348 2299908	4398 2273761	4448 2248201	4498 2223210
4299 2326122	4349 2299379	4399 2273244	4449 2247696	4499 2222716
4300 2325581	4350 2298851	4400 2272727	4450 2247191	4500 2222222

FIG 17 Reciprocals of Numbers (from 4251 to 4500)

The following example shows the extreme case of this method of division through multiplication. If it is required to find the quotient to two decimals in the problem below, proceed as follows:

$$\begin{array}{r}
 5.8964 - 42.79 \\
 = 5.8964 \times 0.2336665 \\
 \begin{array}{r}
 1168 \\
 184 \\
 18 \\
 \hline
 14
 \end{array}
 \end{array}
 \quad \text{Multiplication by } 5\left(\frac{1}{2} \times 10\right)$$

Multiplication by .006 and .0004 is not necessary as the results fall beyond the fourth decimal place.

In all cases where it is necessary to express a series of figures as percentages of a common base, multiplication by reciprocals represents a considerable time saving. Thus in expressing figures on a profit and loss statement as percentages of sales, it is easier to find the reciprocal of the sales figure and then multiply this successively by the cost of sales, gross profit, etc. The same is true where departmental distributions occur. (See discussion later in the Section.)

Experienced calculating machine operators make use of this principle. Repeated divisions with a common divisor are avoided and continued multiplication substituted instead. This saves constant resetting of keys and clearing of dials.

**Continental Method of Division.**—Under the conventional method, the partial quotient is multiplied by the divisor, the product written down under the dividend then subtracted. The multiplication and subtraction may, however, be performed in a single operation by adding to the product a number sufficient to produce the required number in the dividend. An illustration will make this clear.

Divide 624 637 62 by 438 2

(a) Conventional Method	(b) Continental Method
624637 62 - 438 2 =	624637 62 - 438 2 =
6246376 2 - 4382 = <u>1 426 46</u>	6246376 2 - 4382 = <u>1 426 46</u>
4382	18643
18643	11157
17528	23936
11157	20202
8764	27340
23936	
21910	
20202	
17528	
27340	

**Explanation of Continental Method.**—The first partial quotient (6246 - 4382) is 1. Now multiply this by 4382 and add enough to produce 6246. Thus, starting in the unit place,  $1 \times 2 = 2$ , plus 4 = 6. Put down 4.  $1 \times 8 = 8$ , plus 6 = 14. Put down 6, carry 1.  $1 \times 3 = 3$ , plus 1 (carried) = 4, plus 8 = 12. Put down 8, carry 1.  $1 \times 4 = 4$ , plus 1

(called) = 5 plus 1 = 6 Put down 1 The remainder is 1861 In the same way all the other remainders are obtained

**Division by Successive Elimination of Digits of the Divisor**—This method is useful when a limited number of decimal places in the quotient is needed, and the divisor has a considerable number of digits. Then, instead of "bringing down" additional digits of the dividend cut off a digit from the right of the divisor. If a digit less than 5 is cut off, the digit to the left of the one cut off remains unchanged. If the one cut off is 5 or more, the digit to the left in the divisor is increased by 1.

- 1 Divide 607364 by 2137024 finding the result, correct to two decimal places

First move the decimal point 6 places to the right in divisor and dividend, in order to fix the decimal point in the quotient. Continue the division to three decimal places, and drop digits of the divisor instead of supplying zeros in the dividend.

$$\begin{array}{r}
 607364000 - \overset{28}{2137024} = 326188 = \underline{32610} \\
 \begin{array}{r}
 559368 \\
 132284 \\
 4010 \\
 1872 \\
 160
 \end{array}
 \end{array}
 \left\{ \begin{array}{l} \text{Divide by } 213792 \\ \text{" " } 21379 \\ \text{" " } 2138 \\ \text{" " } 214 \\ \text{" " } 21
 \end{array} \right.$$

When 4 and 2 are eliminated from the right of the divisor, the next digit to the left is not changed. When digit 9 is dropped from the divisor, digit 7 to the left is changed to 8 etc. Evidently the labor of multiplying the divisor and subtracting to find the next partial dividend becomes less as the number of digits in both becomes less.

- 2 Find the actual average man hour rate for the overhead in a department, the standing orders total \$14,798.23, the direct labor hours amount to 12,626

$$\begin{array}{r}
 \$14798.23 - \overset{3}{12626} = \$1172 \\
 \begin{array}{r}
 2172 \\
 969 \\
 27
 \end{array}
 \end{array}
 \left\{ \begin{array}{l} \text{Divide by } 1263 \\ \text{" " } 126 \\ \text{" " } 13
 \end{array} \right.$$

## Ratio and Proportion

**RATIO DEFINED**—The ratio of two numbers is the quotient of the first divided by the second. Thus, the ratio of 10 to 2 is 5, the ratio of 2 to 10 is  $\frac{1}{5}$ . Ratios are usually indicated by a fraction line, a colon, or a division sign.

$$\text{Examples } \frac{10}{2} = 5 \quad 21 : 7 = 3, \quad 4 - 28 = \frac{1}{7}$$

Ratios are frequently employed in cost accounting as in making departmental expense distributions (see examples below under Proportional Distribution)

**PROPORTION DEFINED**—A proportion is an equality of ratios, i.e. if the ratio of one pair of numbers is equal to the ratio of another pair of numbers, the two pairs are said to form a proportion. Since  $12 : 3 = 100 : 25$ , the numbers 12, 3, 100, 25 form a proportion. Evidently both ratios equal 4.

$$1 \quad 3 : 21 = 2 : 14 \text{ both ratios} = \frac{1}{7}$$

$$2 \quad \$10 : \$2 = 5 : 1$$

Note that only like things can be compared, as in the last example. The ratio of  $\frac{10}{2} = 5$  is an abstract number. However, the ratio of the number of dollars to the number of men in a problem may be found. An effective way of writing a proportion is as follows:

$$\frac{15}{6} = \frac{25}{10}$$

The products of diagonally opposite pairs of numbers in a proportion are equal each product in this case being 150, obtained by cross-multiplication.

**Direct Proportion**—A direct proportion results from two sets of numbers so related that an increase or decrease in one is accompanied respectively, by an increase or decrease in the other. Thus at a fixed price per yard the number of yards sold and their cost are directly related.

**Finding Missing Number in Proportion**—If any three of the numbers in a proportion are known, the fourth or missing number may easily be found. In the examples below, the missing number is indicated by the letter  $x$ .

**Examples** Find the missing numbers in each of the following proportions expressing each result to the same number of decimal places as the number just above it.

$$1 \quad \frac{x}{28} = \frac{072}{288}$$

Multiplying both sides by 28

$$x = \frac{072 \times 28}{288} = \frac{2016}{288} = 7$$

$$2 \quad \frac{628}{x} = \frac{147}{375}$$

$$x = \frac{375 \times 628}{147} = 1602$$

Unknown quantities on the right-hand side of the proportion may be solved in exactly the same manner by interchanging the left and right sides and solving according to Example 1 or 2 above.

#### Application of Proportion to Cost Calculations—

**Example 1** If  $3\frac{3}{4}$  yards of material \$15 at a total cost of \$141 are required for a unit of product find the material cost in producing 678 units. The proportion is formed as follows:

$$3\frac{3}{4} : 141 = (678 \times 3\frac{3}{4}) : x$$

Reversing the proportion, and writing it in fractional form,

$$\frac{2373}{x} = \frac{7/2}{141}$$

Using Example 2 above as a model,

$$x = \frac{141 \times 2373}{7/2} = 3345.93 \times \frac{2}{7}$$

$$x = \underline{\underline{\$955.08}}$$

Example 2 In preparing a flexible budget, it is found that at 45% of normal capacity the direct labor payroll in Department A is \$1317. Find the direct labor at 65% of normal capacity.

$$\frac{1317}{x} = \frac{45}{65}$$

$$x = \frac{1317 \times 65}{45} = \underline{\underline{\$1902.33}}$$

**Inverse Proportion**—An inverse proportion exists when two sets of quantities are so related that an increase in one is accompanied by a decrease in the other. Thus if men and machines are about equally efficient and a definite job is to be done, the more men are put on the job, the less the time required to finish it.

Example 1 If 6 men turn out 500 units of product in 9 days how many men should be employed to finish 500 units of the same product in 4 days? Evidently the more men the less time it takes. The proportion is inverse.

$$\begin{array}{ccccccc} \text{2nd No Men} & \text{1st No Men} & = & \text{1st No Days} & \text{2nd No Days} \\ \text{or } x & 6 & = & 9 & 4 \\ \frac{x}{6} & = & \frac{9}{4} \\ x & = & \frac{9 \times 6}{4} & = 13.5 \text{ i.e., 14 men} \end{array}$$

Example 2 If 300 units of a product are finished by 12 men in 5 days, how long should it take 15 men of the same efficiency to produce the 300 units? Evidently with more men the time is less. Therefore this is an inverse proportion.

$$\begin{array}{l} 15 \quad 12 = 5 \quad x \\ \frac{5}{x} = \frac{15}{12} \\ x = \frac{12 \times 5}{15} = 4 \text{ days} \end{array}$$

**Proportional Distribution**—In many business situations, a lump sum is to be distributed over a number of items in proportion to certain fixed or agreed ratios. Hence a number is divided in proportion to two or more given numbers when its parts bear the same relation to the number as the given numbers bear to their total. This may be expressed as a continued proportion.

$$a : b : c : d : e = 2 : 3 : 6 : 8 : 11$$

Hence if the number 210 is to be divided in the above proportions the fundamental operation is to total the given numbers ( $2 + 3 + 6 + 8 + 11 = 30$ ) and to find successively  $2/30 \times 210$ ,  $3/30 \times 210$ ,  $6/30 \times 210$



and so forth. The number 210 is thus distributed into the parts 14, 21, 42, 56 and 77. It should be noted that in the proportional distribution this relationship also will hold true  $2/14 = 3/21 = 6/42 = 8/56 = 11/77$ .

As a matter of practical convenience the fundamental operation can be restated as follows. Divide the number (210 in this case) by the total of the given numbers (30) and multiply this result successively by the given numbers. This form of solution is more economical when the numbers are large and the distribution extensive. If the required division does not come out evenly it should be carried to a sufficient number of decimal places so that the final results will give whatever accuracy is needed, i.e., nearest cent, nearest dollar, nearest inch and so forth.

**Example.** Distribute a heat expense of \$1 542 on the basis of the floor area of the various departments

Department A	2 000 sq ft
Department B	2 400
Department C	3 200
Department D	4 700
Total	<u>12 300</u> sq ft

Each department is charged for a portion of heat expense based on the ratio of its area to the total area

Department A	$\frac{2\,000}{12\,300} \times \$1\,542 = \$250.73$
Department B	$\frac{2\,400}{12\,300} \times \$1\,542 = 300.88$
Department C	$\frac{3\,200}{12\,300} \times \$1\,542 = 401.17$
Department D	$\frac{4\,700}{12\,300} \times \$1\,542 = 589.22$
	<u>\$1 542.00</u>

Using the second method described above the procedure is to find a heating cost per square foot and to multiply this unit cost successively by the area of each department

$$\text{Cost per sq ft} = \frac{\$1\,542}{12\,300} = \$125.80$$

Distributions	
Department A	$2\,000 \times \$125.80 = \$251.60$
Department B	$2\,400 \times 125.80 = 301.92$
Department C	$3\,200 \times 125.80 = 402.56$
Department D	$4\,700 \times 125.80 = 590.26$
	<u>\$1 546.34</u>

**SIMULTANEOUS EQUATIONS**—Sometimes in making service department distributions, it is found that each of a group of service departments must bear a portion of the expense of every other department. Such departments are mutually interdependent and are said to create a vicious circle. In order to close any one departmental account its total expense must be known. This, however, is impossible unless all other department(s) have first been closed. Simultaneous equations offer one method of solution for this type of problem. (For complete discussion of other types of solutions, see Section 18 on Overhead Distribution.)

**Method of Solution**—The most commonly used method is to eliminate unknowns by adding or subtracting equations, term by term, after making their coefficients alike, until only one letter remains in an equation.

**Example 1** In the following example, make the necessary expense distributions and show the completed ledger accounts

	Direct Charges
Producing Department A	\$ 3 700
Producing Department B	4 400
Service Department C	2 300
Service Department D	1 800
Total	<u>\$12 200</u>

The service department expenses are distributed as follows

Department C		Department D	
To A	40%	To A	50%
B	30%	B	30%
D	30%	C	20%

Let  $e$  = Total direct and redistributed expense in Dept C

$d$  = Total direct and redistributed expense in Dept D

$$e = 2\,300 + 20d$$

$$d = 1\,800 + 30e$$

$$(1) \quad e - 20d = 2\,300$$

$$(2) \quad -30e + d = 1\,800$$

Multiply (2) by 2 and add to (1)

$$\begin{array}{r} e - 2d = 2\,300 \\ - 60e + 2d = 360 \\ \hline 59e = 2\,660 \\ e = \$2\,829.79 \end{array}$$

$$\text{From } d = 1\,800 + 3e$$

$$d = 1\,800 + 8\,489.4 = \$2\,648.94$$

#### DEPARTMENT A

Direct Charges	\$3 700 00
From C	(1) 1 131 92
D	(2) 1 324 47
	<u>\$6 156 39</u>

#### DEPARTMENT B

Direct Charges	\$4,400 00
From C	(1) 848 93
" D	(2) 794 68
	<u>\$6 043 61</u>

#### DEPARTMENT C

Direct Charges	\$2 300 00	Distribution	
From D	(2) 529 79	To A 40% of total	(1) \$1 131 92
		B 30% " "	(1) 848 93
		D 30% " "	(1) 848 94
	<u>\$2 829 79</u>		<u>\$2 829 79</u>

## DEPARTMENT D

Direct Charges	\$1 800 00	Distribution			
From C	(1) 848 04	To A	50%	of total	(2) \$1 324 47
		B	30%	" "	(2) 794 68
		C	20%	" "	(2) 520 79
	<u>\$2 648 04</u>				<u>\$2 648 04</u>

**Example 2** The following problem is taken from Moreland and McKee (Accounting for the Petroleum Industry). The total expenses of four service clearing accounts in a certain process plant before clearance has been made to the other accounts within this group are as follows:

Steam plant expense	\$ 523
Pumping plant expense	170
Water plant expense	106
Electric plant expense	201
Total	<u>\$1 000</u>

The expenses as above shown are fairly allocable to each other and to all other departments and process costs in the following ratios:

	Allocable to				
Plants	Steam	Pumping	Water	Electric	All Other
Steam		8%	4%	19%	69%
Pumping	9%		17	3	71
Water	22	3		2	73
Electric	5	18			77

Calculate the service department expenses chargeable to the other department processes and submit ledger accounts of all departments.

Let  $s$  = Total steam expense including allocation from other service departments

$p$  = Corresponding pumping service total

$w$  = Corresponding water service total

$e$  = Corresponding electric service total

Then from the table given

$$s = 00p + 22w + 05e + \$523$$

$$p = 08s + 03w + 18e + 170$$

$$w = 04s + 17p + 106$$

$$e = 19s + 03p + 02w + 201$$

Multiplying both sides of each equation by 100, and assembling all letters on the left, dollars on the right gives

$$\begin{array}{rclcl} (1) & 100s & - & 0p & - & 22w & - & 5e & = & \$52\,300 \\ (2) & -8s & + & 100p & - & 3w & - & 18e & = & 17\,000 \\ (3) & -4s & - & 17p & + & 100w & & & = & 10\,600 \\ (4) & -19s & - & 3p & - & 2w & + & 100e & = & 20\,100 \end{array}$$

Multiply (1) by 20, and add it to (4)

$$\begin{array}{rclcl} (4) & 2,000s & - & 180p & - & 440w & - & 100e & = & 1\,046\,000 \\ & -19s & - & 3p & - & 2w & + & 100e & = & 20,100 \end{array}$$

$$(A) \quad 1,981s - 183p - 442w = 1,066\,100$$

Multiply (1) by 18 and (2) by 5 and subtract

$$\begin{array}{r} 1800s - 162p - 306w - 90e = 941\ 400 \\ -40s + 500p - 15w - 90e = 85\ 000 \end{array}$$

$$(B) \quad 1,840s - 662p - 381w = 856\ 400$$

Multiply (B) by 100, and (3) by 381, and add

$$\begin{array}{r} 184,000s - 66200p - 38100w = 85\ 640\ 000 \\ -1\ 524s - 6\ 477p + 38100w = 4\ 038\ 600 \end{array}$$

$$(C) \quad 182\ 476s - 72,677p = 89\ 678\ 600$$

Multiply (A) by 100, and (3) by 442 and add

$$\begin{array}{r} 198\ 000s - 18\ 300p - 44\ 200w = 106\ 610\ 000 \\ -1\ 768s - 7\ 514p + 44\ 200w = 4,685\ 200 \end{array}$$

$$(D) \quad 196\ 332s - 25\ 814p = 111\ 295\ 200$$

Divide (D) by 25 814 and (C) by 72,677 then subtract

$$\begin{array}{r} 7\ 60504s - p = 4\ 311\ 427 \\ 2\ 51078s - p = 1\ 233\ 034 \end{array}$$

$$\begin{array}{r} 5\ 09486s = 3\ 077\ 493 \\ s = \$\ 604\ 04 \end{array}$$

From the next to the last equation,

$$\begin{array}{r} 2\ 51078s - p = 1\ 233\ 034 \\ 1516\ 61 - p = 1\ 233\ 03 \\ p = \$\ 282\ 68 \end{array}$$

From (3),

$$\begin{array}{r} -4s - 17p + 100w = 10\ 600 \\ -2416\ 18 - 4805\ 50 + 100w = 10\ 600 \\ w = \$\ 178\ 22 \end{array}$$

From (4),

$$\begin{array}{r} -19s - 3p - 2w + 100e = 20\ 100 \\ -11,476\ 76 - 848\ 04 - 356\ 44 + 100e = 20,100 \\ e = \$327\ 81 \end{array}$$

## STEAM

Direct Charges	\$ 523 00	Distribution	(1) \$ 604 04
Pumping	(2) 25 44		
Water	(3) 30 21		
Electric	(4) 16 39		
	<u>\$604 04</u>		<u>\$ 604 04</u>

## PUMPING

Direct Charges	\$ 170 00	Distribution	(2) \$ 282 68
Steam	(1) 48 32		
Water	(3) 5 35		
Electric	(4) 50 01		
	<u>\$ 282 68</u>		<u>\$ 282 68</u>

## WATER

Direct Charges	\$ 106 00	Distribution	(3) \$ 178 22
Steam	(1) 24 16		
Pumping	(2) 48 06		
	<u>\$ 178 22</u>		<u>\$ 178 22</u>

## ELECTRIC

Direct Charges	\$ 201 00	Distribution	(4) \$ 327 81
Steam	(1) 114 77		
Pumping	(2) 8 48		
Water	(3) 3 56		
	<u>\$ 127 81</u>		<u>\$ 327 81</u>

## ALL OTHERS

Steam	(1) \$ 416 79
Pumping	(2) 200 70
Water	(3) 130 10
Electric	(4) 252 41
	<u>\$1 000 00</u>

**INTERPOLATION**—Many types of information involving mathematical calculations have been worked up into extensive tables from which results can be read without the necessity of performing or even understanding the fundamental mathematics involved. Examples of such tables are those for square roots of numbers, logarithms, compound interest functions, and bond tables. Even the most extensive of these tables, however, often fail to give the required information directly since the readings sought fall between the readings given in the table.

When a desired item falls between two items of a table being used, its value can be found with sufficient accuracy for practical purposes by a process called **interpolation**. Interpolation in a table means finding the value of a required item which lies between two items in the table. Examples are given below.

**Example 1** From Fig 18 find the reciprocal of 4265.5. The table shows the reciprocals of 4265 and 4266. It is therefore assumed that the reciprocal of 4265.5 is halfway between the two given reciprocals.

4265	=	0002344666
4266	=	0002344116
Tabular Difference		550
One half	=	275

Therefore the reciprocal of 4265.5 is 0002344666 minus 275 = 0002344391. Note that the proportion is inverse, i.e. as the number increases, the reciprocal decreases.

**Example 2** Find the reciprocal of 44337. From Fig 18, read the reciprocals of 4433 and 4434.

4433	=	2 256809
4434	=	2 257300
Tabular Difference		500
Required interpolation		500 $\times$ 7 = 356

The required reciprocal lies 7 of the distance between 4433 and 4434. Hence interpolate for 7 as above and deduct the result (356) from 2 255809, the answer is 2 255453.

For interpolation in logarithm tables, see discussion later in this section.

**Warning.** The results of these interpolations are not correct in an absolute sense because the method of interpolating assumes that the values of the tables change along straight lines between table readings whereas the true readings fall along a curved line. For most practical purposes however the error is negligible.

## Logarithms

**LOGARITHMS DEFINED.**—The logarithm (or log) of a number is generally defined as the power to which 10 must be raised to produce that number. Thus the log of 100 is 2, because  $10^2 = 100$ , the log of 10,000 is 4 because  $10^4 = 10,000$ . As a background for further discussion the following tabulation will be useful.

$10^{-4} =$	0001	that is the log of	0001 =	-4
$10^{-3} =$	001	" " " " "	001 =	-3
$10^{-2} =$	01	" " " " "	01 =	-2
$10^{-1} =$	1	" " " " "	1 =	-1
$10^0 =$	1	" " " " "	1 =	0
$10^1 =$	10	" " " " "	10 =	1
$10^2 =$	100	" " " " "	100 =	2
$10^3 =$	1,000	" " " " "	1,000 =	3
$10^4 =$	10,000	" " " " "	10,000 =	4

This table can of course be extended up or down indefinitely.

The next step is to consider the significance of fractional or decimal powers of 10 such as  $10^{1.25}$  or  $10^{3.451172}$ . It is obvious that the value of  $10^{1.25}$  lies between  $10^1$  and  $10^2$  and therefore between 10 and 100 (It is 17.783). Likewise  $10^{3.451172}$  lies between  $10^3$  and  $10^4$  and therefore between 1,000 and 10,000 (It is 2,826). These relationships may be restated as follows. The log of 17.783 is 1.25, the log of 2,826 is 3.451172.

From the foregoing it should be clear that the logs of all numbers other than the even powers of 10 will consist of a whole number and a decimal. The whole number part of each log can be determined by inspection. The decimal part of the log can be determined practically only by reference to a log table.

**LOG TABLES.**—Log tables are published as appendices in many mathematics books, and as separate volumes. Commonly available tables are carried out to six or seven decimals and provide sufficient accuracy for ordinary purposes. Tables up to twenty or more decimals are used for certain purposes. The logs of certain especially important numbers such as typical interest rates are often given in special tables to a considerable number of places. Langer and Gill (Mathematics of Accounting and Finance) give 15 place logs of 240 interest rates (in the form of  $1 + i$ ) running from 1.00025% to 1.10000%. Kent's tables (Compound Interest and Annuity Tables) give 10 place logs of 168 fractional

interest rates (in the form  $1 + i$ ) for the most commonly useful rates from 1/20 to 1% Good tables of logs commonly available are Chambers' and Vega's.

The usual form of 7-place log tables (see Fig 18 for sample page) lists the first four digits of the number down the left margin of the page, the last digit of the number across the top of the page, and the decimal part of the corresponding logs (i.e., the mantissa) in ten columns on the body of the page. Since the first two or three digits of the mantissa repeat for considerable ranges, they are often placed in a special column at the left and shown only when they change.

**FINDING THE LOG OF A NUMBER**—By reference to the sample page shown the technique of finding the log of a number may be illustrated. Find the log of 10326. Look down the number column at the left to number 1032 and along its line to the column headed 6. The number 9321 together with the first three nonrepeated digits at left gives the complete mantissa, 013 9321. The whole number part of the log (its characteristic) is 4 since the number 10326 lies between 10 000 and 100 000. Thus the complete log is 4 013 9321. If the number had been 1.0326, the process of finding its log would have been the same, since it is composed of the same sequence of digits except that its characteristic would have been 3 and the resulting log 3 013 9321.

In the table, the light ruling above the last four digits of some of the mantissas indicates that those four digits are to be used with the non-repeated digits on the next lower line. For instance, the log of 10362 is 4 015 0243, the log of 10426 is 2 018 1177.

Finding the characteristic for numbers less than 10 and for decimals is simply an extension of this process as is seen by an inspection of the following:

log	10 326	=	4 013 9321	
log	1 032 6	=	3 013 9321	
log	103 26	=	2 013 9321	
log	10 320	=	1 013 9321	
log	1 0326	=	013 9321	
log	10326	=	-1 + 013 9321	(or 9 013 9321 - 10)
log	010326	=	-2 + 013 9321	(or 8 013 9321 - 10)
log	0010326	=	-3 + 013 9321	(or 7 013 9321 - 10)
log	00010326	=	-4 + 013 9321	(or 6 013 9321 - 10)

Log 010326 can be written in the two methods shown or as -1 986 0679 all three methods being mathematically identical. The method of showing it as 8 013 9321 - 10 is the easiest to handle in actual calculations. It is safest to determine the characteristic in each case by reference to the fundamental concept of the powers of 10. Many persons, however, prefer an arbitrary rule of thumb for the purpose. Here is one that works. For whole numbers, the characteristic is always 1 less than the number of digits left of the decimal point, for decimals the characteristic is minus in sign (the mantissa remaining positive) and its absolute value is one more than the number of zeros between the decimal point and the first significant digit.

**INTERPOLATION**—When it is necessary to find the log of a number which is not given directly in the table, recourse may be had

to interpolation Find, for example, the log of 103,265 in the sample log table given The table gives directly the mantissa for 103,260 which is 013 9321, and for 103,270, which is 013 9742 Since the selected number lies half-way between 103,260 and 103,270 by the general rules of interpolation its mantissa will lie half-way between the mantissas of those numbers and may be calculated as follows

$$013\ 9321 + 1/2 (013\ 9742 - 013\ 9321) = 013\ 9531$$

Having found the mantissa, the characteristic is determined and the complete log is 5 013 9531 Similarly, it may be assumed that the log of 103,263 lies 3/10 of the way from log of 103,260 to log of 103,270 The calculation is as follows

$$013\ 9321 + 3/10 (013\ 9742 - 013\ 9321) = 013\ 9447$$

and the complete log is 5 013 9447

The differences between successive mantissas on the sample page vary from 435 to 413 Most log tables include on the margins of the pages small tables of proportional parts to facilitate the calculation of the interpolation The excerpt given is illustrative For the number 103,263 the mantissa (using the table of proportional parts) is calculated as follows

P P	
421	
1	421
2	842
3	1263
4	1684
5	2105
6	2526
7	2947
8	3368
9	3789

$$013\ 9321 + 0000126 = 013\ 9447$$

**FINDING THE ANTI-LOG**—Finding the number whose log is known (i.e., the anti-log) is the reverse of the process of finding the log when the number is known

**Example** Find the anti log of 2 018 0135 Referring to Fig 18 the given mantissa of 018 0135 is found to lie between the tabulated mantissas of 017 9927 and 018 0344 corresponding to the numbers 10423 and 10424 respectively By computation moreover the given mantissa is found to be about half way from one tabulated mantissa to the other The desired value is accordingly half way from 10423 to 10424 or 104235 The final step is placing the decimal point Since the given characteristic is 2 the number is 104 235

With a characteristic of zero and the given mantissa of 018 0135 the anti log is 1 04235 Given the logarithm 7 018 0135-10 the anti log is 00104235

**USING LOGS TO SOLVE PROBLEMS**—The use of logs in solving problems depends entirely on knowledge of the laws of exponents or powers These laws may be demonstrated by setting up a series of parallel illustrations simple enough to be checked by actual arithmetic calculation



No		0	1	2	3	4		5	6	7	8	9
1000	000	0000	0434	0869	1303	1737		2171	2605	3039	3473	3907
01		4341	4775	5208	5642	6076		6510	6943	7377	7810	8244
02		8677	9111	9544	9977	0411		0844	1277	1710	2143	2576
03	001	3009	3442	3875	4308	4741		5174	5607	6039	6472	6905
04		7377	7770	8202	8635	9067		9499	9932	0364	0796	1228
05	002	1661	2093	2525	2957	3389		3821	4253	4685	5116	5548
06		5980	6411	6843	7275	7706		8138	8569	9001	9432	9863
07	003	8295	8726	9157	9588	2019		2451	2882	3313	3744	4174
08		4605	5036	5467	5898	6328		6759	7190	7620	8051	8481
09		8912	9342	9772	0203	0633		1063	1493	1924	2354	2784
10	004	3214	3644	4074	4504	4933		5363	5793	6223	6652	7082
1011		7512	7941	8371	8800	9229		9659	0088	0517	0947	1376
12	005	1805	2234	2663	3092	3521		3950	4379	4808	5237	5666
13		6094	6523	6952	7380	7809		8238	8666	9094	9523	9951
14	006	0380	0808	1236	1664	2092		2521	2949	3377	3805	4233
15		4660	5088	5516	5944	6372		6799	7227	7655	8082	8510
16		8937	9365	9792	0219	0647		1074	1501	1928	2355	2782
17	007	3210	3637	4064	4490	4917		5344	5771	6198	6624	7051
18		7478	7904	8331	8757	9184		9610	0037	0463	0889	1316
19	008	1742	2168	2594	3020	3446		3872	4298	4724	5150	5576
20		6002	6427	6853	7279	7704		8130	8556	8981	9407	9832
1021	009	0257	0683	1108	1533	1959		2384	2809	3234	3659	4084
22		4509	4934	5359	5784	6208		6633	7058	7483	7907	8332
23		8756	9181	9605	0030	0454		0878	1303	1727	2151	2575
24	010	3000	3424	3848	4272	4696		5120	5544	5967	6391	6815
25		7239	7662	8086	8510	8933		9357	9780	0204	0627	1050
26	011	1474	1897	2320	2743	3166		3590	4013	4436	4859	5282
27		5704	6127	6550	6973	7396		7818	8241	8664	9086	9509
28		9931	0354	0776	1198	1621		2043	2465	2887	3310	3732
29	012	4154	4576	4998	5420	5842		6264	6685	7107	7529	7951
30		8372	8794	9216	9637	0059		0480	0901	1323	1744	2166
1031	013	2587	3008	3429	3850	4271		4692	5113	5534	5955	6376
32		6797	7218	7639	8059	8480		8901	9321	9742	0162	0583
33	014	1003	1424	1844	2264	2685		3105	3525	3945	4365	4785
34		5205	5625	6045	6465	6885		7305	7725	8144	8564	8984
35		9403	9823	0243	0662	1082		1501	1920	2340	2759	3178
36	015	3598	4017	4436	4855	5274		5693	6112	6531	6950	7369
37		7768	8206	8625	9044	9462		9881	0300	0718	1137	1556
38	016	1674	2092	2510	2929	3347		3765	4183	4601	5019	5437
39		6155	6573	6991	7409	7827		8245	8663	9080	9498	9916
40	017	0333	0751	1168	1586	2003		2421	2838	3256	3673	4090
1041		4507	4924	5342	5759	6176		6593	7010	7427	7844	8260
42		8677	9094	9511	9927	0344		0761	1177	1594	2010	2427
43	018	2843	3259	3676	4092	4508		4925	5341	5757	6173	6589
44		7005	7421	7837	8253	8669		9084	9500	9916	0332	0747
45	019	1163	1578	1994	2410	2825		3240	3656	4071	4486	4902
46		5317	5732	6147	6562	6977		7392	7807	8222	8637	9052
47		9467	9882	0296	0711	1126		1540	1955	2369	2784	3198
48	020	3613	4027	4442	4856	5270		5684	6099	6513	6927	7341
49		7755	8169	8583	8997	9411		9824	0238	0652	1066	1479
1050	021	1893	2307	2720	3134	3547		3961	4374	4787	5201	5614

FIG 18 Sample Page from Table of Logarithms to Seven Decimal Places

**Case I To multiply numbers**

- (a)  $x^3 \times x^5 = x^8$  (by the laws of algebra)  
 (b)  $2^2 \times 2^4 = 2^6$  (1 e.  $4 \times 16 = 64$ )  
 (c)  $10^3 \times 10^4 = 10^7$  (1 e.  $1\,000 \times 10\,000 = 10\,000\,000$ )  
 (d)  $10^4 \text{ } 008 \text{ } 8310 \times 10^2 \text{ } 012 \text{ } 1198 = 10^6 \text{ } 018 \text{ } 9708 = 1\,044\,650^*$   
 (1 e.  $10\,150 \times 102\,83 = 1\,044\,649\,97^*$ )

\* There may be a slight error if 7 place logs are used for figures as large as these

The rule illustrated by this demonstration is as follows To multiply two or more numbers add their logs and find the anti log

**Case II To divide numbers**

- (a)  $x^9 \div x^4 = x^5$  (by the laws of algebra)  
 (b)  $2^5 \div 2^2 = 2^3$  (1 e.  $32 \div 4 = 8$ )  
 (c)  $10^6 \div 10^4 = 10^2$  (1 e.  $1\,000\,000 \div 10\,000 = 100$ )  
 (d)  $10^3 \text{ } 019 \text{ } 3240 \div 10^1 \text{ } 010 \text{ } 0300 = 10^2 \text{ } 008 \text{ } 2940 = 100\,76135$   
 (1 e.  $1\,045\,5 \div 10\,376 = 100\,76137$ )  
 (e)  $10^1 \text{ } 016 \text{ } 0300 \div 10^3 \text{ } 010 \text{ } 3240 = 10^7 \text{ } 990 \text{ } 7060 \div 10 = 009924440$   
 (1 e.  $10\,376 \div 1\,045\,5 = 009924438$ )

The rule illustrated by this demonstration is as follows To divide one number into another, subtract the log of the divisor from the log of the dividend and find the anti log

The subtraction of the log is handled as follows

$$\begin{array}{r}
 \text{either} \quad - \quad \begin{array}{r} 1\,016\,0300 \\ 3\,019\,3240 \\ \hline -2\,003\,2940 \\ +10 \quad \quad \quad -10 \\ \hline 7\,996\,7060 -10 \end{array} \quad \text{or} \quad - \quad \begin{array}{r} 11\,016\,0300 -10 \\ 3\,019\,3240 \\ \hline 7\,996\,7060 -10 \end{array}
 \end{array}$$

This log cannot be read from the sample page of logs

**Case III To raise to a power**

- (a)  $(x^2)^4 = x^{2 \times 4} = x^8$  (by the laws of algebra)  
 (b)  $(2^3)^4 = 2^{3 \times 4} = 2^{12}$  (1 e.  $(8)^4 = 2^{12} = 4\,096$ )  
 (c)  $(10^4)^2 = 10^{4 \times 2} = 10^8$  (1 e.  $(10\,000)^2 = 10^8 = 100,000\,000$ )  
 (d)  $(10^3 \text{ } 017 \text{ } 8977)^2 = 10^6 \text{ } 063 \text{ } 0081 = 1\,131\,400,000$   
 (1 e.  $(1\,042)^3 = 1\,131\,366,088$ )

The rule illustrated by this demonstration is as follows To raise any number to a power multiply its log by the exponent of the power and find the anti log

**Case IV To find a root**

- (a)  $\sqrt[3]{x^{12}} = x^{12 \div 3} = x^4$  (by the laws of algebra)  
 (b)  $\sqrt[3]{2^6} = 2^{6 \div 3} = 2^2 = 4$  (1 e.  $\sqrt[3]{64} = 4$ )  
 (c)  $\sqrt[4]{10^8} = 10^{8 \div 4} = 10^2 = 100$  (1 e.  $\sqrt[4]{100\,000\,000} = 100$ )  
 (d)  $\sqrt[5]{10^5 \text{ } 456 \text{ } 5760} = 10^5 \text{ } 456 \text{ } 5760 \div 5 = 10^1 \text{ } 001 \text{ } 3152 = 12\,34$   
 (1 e.  $\sqrt[5]{280\,138} = 12\,34$ )

The rule illustrated by this demonstration is as follows To find the root of any number divide the log of the number by the index of the root and find the anti log

**Case V Successive calculations** When the solution of a practical problem requires several successive calculations the final result may often be determined by a careful manipulation of the logs without the necessity of finding the anti logs for partial solutions

**Example 1** Find the capacity in gallons of a cylindrical tank with a diameter of 167.5 inches and a height of 85.3 inches. The calculation requires finding the volume of the tank in cubic inches by the formula  $\text{height} \times .785 \times \text{square of the diameter} \times \pi$  and dividing this by 231 the cubic inches in a gallon. Setting this up for calculation

$$\frac{85.3 \times .785 \times (167.5)^2 \times 3.1416}{231}$$

The solution by use of logs for the successive operations is

$$\begin{aligned} \log \text{ of solution} &= \log 85.3 + \log \text{ of } .785 + (2 \times \log 167.5) + \\ &\quad \log 3.1416 - \log 231 \\ \log 85.3 &= 1.930\ 9400 \\ \log .785 &= 9.397\ 9400 - 10 \\ (\log 167.5 &= 2.224\ 0148) \\ 2 \times \log 167.5 &= 4.448\ 0206 \\ \log 3.1416 &= 497\ 1500 \\ \log \text{ of entire numerator of fraction} &= 16.274\ 0693 - 10 \\ \log 231 &= 2.363\ 6120 \\ \log \text{ of solution} &= 13.910\ 4573 - 10 \\ \log \text{ of solution rewritten} &= 3.910\ 4573 \\ \text{solution (anti } \log 3.910\ 4573) &= 8\ 136.87 \text{ gallons} \end{aligned}$$

**Example 2** The calculation of the geometric average of ten numbers requires the finding of the product of the ten numbers, and then the extraction of the 10th root of the product. Using logs this is accomplished as follows

$$\begin{aligned} \log 16 &= 1.204\ 1200 \\ \log 18 &= 1.255\ 2725 \\ \log 19 &= 1.278\ 7530 \\ \log 19.2 &= 1.283\ 3012 \\ \log 19.6 &= 1.293\ 2561 \\ \log 19.9 &= 1.298\ 8531 \\ \log 20 &= 1.301\ 0300 \\ \log 20.5 &= 1.311\ 7539 \\ \log 21 &= 1.322\ 2103 \\ \log 21 &= 1.301\ 7278 \\ \log \text{ of the product} &= 12.909\ 2875 \\ \log \text{ of the } 10^{\text{th}} \text{ root} &= 12.909\ 2875 - 10 = 2.909\ 2875 \\ 10^{\text{th}} \text{ root} = \text{geometric average} &= 19.54 + \end{aligned}$$

### Slide Rule

**SLIDE RULE DEFINED**—A slide rule is a calculating device based on logarithms. It can be used for original computations in which three or four digits in the result are sufficient and for checking computations otherwise made. Calculations involving multiplication, division, powers, and roots are performed with its help (Fig. 19).

This instrument can be used for checking a payroll at any rate per hour, for solving any problem solvable by proportion, calculating interest, discount, or percentage, converting foreign money to equivalent domestic money, any measure to a related measure, etc. Its great advantage is that the computations are made almost instantly by simply moving the slide back and forth. In continued multiplication or division intermediate partial results need not be read and the final result can be obtained without such reading of results of intermediate processes.

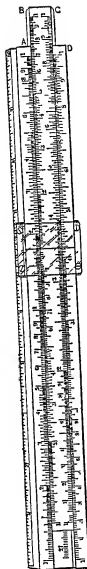


FIG 19 Slide Rule

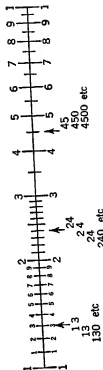


FIG 20 Division Points on Slide Rule

**SCALES OF THE SLIDE RULE**—The ordinary slide rule has four principal scales on its face, usually called the A, B, C and D scales (Fig 19). The A and B scales are subdivided in the same way, and the C and D scales are also subdivided like A and B scales are repeated scales, each half representing a full scale, and being one half as long as a C or D scale.

Any one of these scales may be used to represent any real number of the number system, either exactly or approximately. The first (left) digit of the number is represented by one of the ten major divisions of the scale. The second digit from the left by one of the second order of divisions following this selected major division, and so on.

For example, in Fig. 20, reading from left to right over the scale, the large digits pointed at the points of division may be designated as 1, 2, 3, 10, or 10, 20, 30, 40, 100 or 100, 200, 300, 400, 1,000. By showing ten major divisions, and the next order of divisions (10 between each two of the major divisions), it is possible to pick out exactly the first two digits of any number, or any number having the first two digits other than zero, followed by any number of zeros. In other words a slide rule gives only the sequence of digits, without the decimal points.

**Reading the Scales**—In Fig 20 the position on the scale pointed out by the first arrow on the left may be read 13, 13, 130, 13,000, etc. Similarly, the second arrow points to a scale division following the large 2 and is four second order units beyond 2. This position indicates a number whose first two digits are 24, and may be read 24, 24, 24, 240, etc., depending on the nature of the computation. Note that second order divisions are shown between large 1 and large 2 and between large 2 and large 3 but not between the remaining first order divisions. In Fig 20 the third arrow from the left is pointing exactly at the position which represents 45, 45, 450, 4,500, etc.

Spacing between first order digits 2 and 3 and between 3 and 4, shows all second order divisions by long strokes or cross lines on the scale. The space is too small to show all third order divisions between these second order divisions. Each two digits of the third order are indicated, however.

On the C and D scales from left digit 4 to left digit 10, only every 5 units of the third order are shown by the smallest spaces.

**Relation of Scales to Logarithms**—The scales of a slide rule really represent a log table in graphic form. Since the mantissa of log 1 is 0,

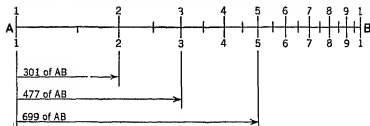


FIG 21 Relation of Slide Rule to Logarithms

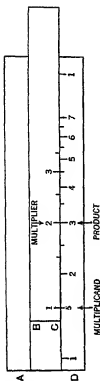


FIG 22 Multiplication on Slide Rule

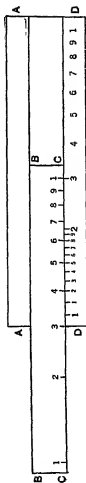


FIG 23 Multiplication on Slide Rule

the first order digit 1 is 0 distance from the left end of the scale. Since the mantissa of  $\log 2$  is 301030, the distance from 1 to 2 represents 301 of the length of the entire scale. Similarly, the distance from 1 to 3 is 477 of the length of the scale, because mantissa of  $\log 3$  is 477121 (Fig 21).

**MULTIPLICATION BY USE OF SLIDE RULE**—To multiply two numbers their logs are added. Since the distances to numbers on a slide rule scale represent the mantissas of numbers, there multiplication may be accomplished by adding line segments on the slide rule. Fig 22 shows multiplication of  $15 \times 2$ . Set left index of C over 15 on D scale, then go to 2 on C, and under it read 30 (i.e., 30) on D.

In many cases of multiplying the sum of the mantissas of the numbers multiplied is greater than 1. In this case if the slide is moved to the right, the multiplier is off the C scale to the right, and in this position the product cannot be read. When this happens set the right index of C over the multiplicand on D, go to the multiplier on C, and drop down to product under it on D. Thus, multiplying 3 by 6 is accomplished as in Fig 23.

Note that when the slide is placed as shown, the product of 3 multiplied by 6, 5, or 4 may be read. On D, under large 6 is 18, under 4 is 12, and under 5 is found 15.

**Fixing the Decimal Point in Product**—If when the product is obtained, the slide projects to the right the characteristic of the log of the product is the sum of the characteristics of the logs of the numbers multiplied.

Example Multiply 15 by 175

Setting left index of C over 15 on D, under 175 on C read 2625 on D. The slide projects to the right.

Characteristic of log	15 = 1
Characteristic of log	175 = 2
Characteristic of product	= 3

Therefore there are four digits to left of decimal point. The answer is 2625.

If in multiplying, the slide must be moved to the left to be able to read the product on D, it means that the sum of the mantissas of the logs of the numbers is greater than 1 and therefore the sum of mantissas of logs of the numbers must be increased by 1.

Example Multiply 85 by 33

Setting right index of C over 85 on D, under 33 on C read 280 +, with the slide projecting to the left.

Characteristic of log	85 = 1
Characteristic of log	33 = 1
Characteristic of product	= 3 (i.e. 2 + 1)

There are 4 digits in the product. Since right digit 5 by right digit 3 gives 15, the product must end in 5. The number is 2805.

**Continued Multiplication**—The runner of the slide rule with its hair-line makes continued multiplication easy. Suppose the product  $14 \times 13 \times 70$  is desired. Set the left index of C over 14 on D, and move runner so that the hair-line crosses 13 on C. This marks on the D scale the product of  $14 \times 13$ . Now pull the slide to the right bringing the left index of C under the hair-line. Move the right index of C under the hair-line, and read the digits 1234 on D under 7 on C. As the characteristics of the logarithms of the factors are 1, 1, 1 and there is 1 to carry (slide moved left once), the characteristic of the product is 4, hence there are five digits to the left of the decimal, and the product is 12,740.

**DIVISION BY USE OF SLIDE RULE**—Division on the slide rule is performed by subtracting line segments which is equal to subtracting the mantissas of the logs of the numbers. The procedure is to select the dividend or numerator on the D scale, then set the divisor or denominator on C over the dividend on D, read the quotient under 1 of the C scale.

**Example 1** In dividing 8 by 4 when the divisor 4 is set above 8 on D the left index of C remains above D. Under it read quotient 2. Note that the slide projects to the right in Fig. 24.

**Fixing the Decimal Point in the Quotient**—Subtract the characteristic of the log of the divisor from that of log of the dividend. If the slide projects to the right the difference is the characteristic of the log of the quotient. If the slide projects to the left in performing the division reduce this difference by 1 in order to find the characteristic of the log of the quotient.

**Example 1**  $445 \div 31$ , slide projects right

$$\begin{array}{rcl} \text{Characteristic log} & 445 & = 2 \\ \text{Characteristic log} & 31 & = 1 \\ \text{Characteristic log of the quotient} & & = 1 \end{array}$$

Therefore the quotient is 14.34

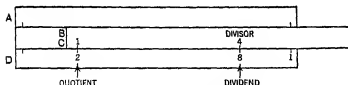


FIG. 24 Division on Slide Rule

**Example 2**  $23 \div 032$  The digits of the quotient are 719 and the slide projects to the left in dividing

$$\begin{array}{rcl} \text{Characteristic log} & 23 & = 0 \\ \text{Characteristic log} & 032 & = \bar{2} \\ \text{Characteristic log of quotient} & & = 1 \quad [0 - (-2) - 1 = +1] \end{array}$$

The quotient is 71.9 approximately



**Continued Multiplication and Division**—The approximate result, correct to three digits, can be found by the slide rule in such examples as the following

Find the value of the expression

$$\frac{87 \times 45 \times 155}{92 \times 485 \times 125}$$

Using the runner as described under continued multiplication, the product  $87 \times 45 \times 155$  is obtained. This result is then divided by 92 the resulting first quotient by 485 and the second quotient by 125. Under the left index of C read the digits of the final result 1, 0, 8, 8. To fix the decimal point, indicate in the numerator and denominator the characteristics of the factors. To these both in the numerator and the denominator, add 1 for each time the slide projects left in carrying out the operations. In the example above, the slide projected left once in the dividend multiplying, and once in carrying out the succession divisions. These facts may be indicated thus

$$\begin{array}{r} 0 \quad 1 \quad 2 \quad +1 = 4 \\ 87 \times 45 \times 155 \\ 92 \times 485 \times 125 \\ 0 \quad 1 \quad 1 +1 = 3 \end{array}$$

Characteristic of the log of the quotient =  $+1$

As the digits of the final result are 1088, and the characteristic is  $+1$ , there are two digits to the left of the decimal point. Hence the quotient is 10.88 approx.

**PROPORTION ON SLIDE RULE**—If a given number, as 3 on C, is set above another given number, as 4 on D, all the numbers on C have the same ratio to the numbers opposite them on D as the first two. In the given case,  $3/4$ . If this is done, read from C to D  $3/4 = 4/5$ ,  $3/4 = 5/6$ ,  $6/7 = 8/9$  etc. If four numbers are in direct proportion, three being known, the fourth is found by the slide rule, thus

Set the first term on C over the second term on D, and under the third term on C, read the fourth term on D.

**Example 1** If 2 yards cost 19 cents what is the cost of 325 yards? As shown in Fig. 25, set 2 on C over 10 on D, move to 325 on C and under it on D read the cost \$30.90 to the nearest cent.

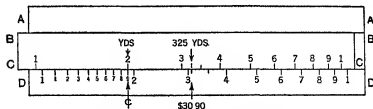


FIG. 25 Solving Proportions by Slide Rule

Foreign units of measure may be translated to United States units through use of the slide rule. For a given quantity such as a given length of cloth, as the measure in meters is increased its equivalent measure in yards is increased. Such problems are solved by direct proportion. Then if on D the number of inches in a meter (39.36) is picked out, and that number is set below 36 on the C scale, all numbers on C then represent the number of meters corresponding to the number of yards just below it. Or since  $39.36 - 36 = 1.093$ , for every meter of length, there corresponds 1.093 yards. Hence set 1 of C over 1.093 on D, then every number on C represents a number of meters, and below it on D the equivalent number of yards is found.

The proportions may be read

$$\frac{1\text{m}}{1.09\text{ yds}} = \frac{19\text{m}}{20.8\text{ yds}} = \frac{25\text{m}}{27.3\text{ yds}} = \frac{35\text{m}}{38.25\text{ yds}} \text{ etc}$$

When the slide rule is thus set an inventory or invoice given in meters can be easily changed to yards without moving the slide. If a particular number of meters on C is off the D scale, set the A and B scales in the same way (1 of B opposite 1.09 of A) and read the number of meters on B and the corresponding number of yards on A.

**The A and B Scales**—The two scales at the top of the slide rule. A on the rule, B on the slide, are also logarithmic scales. However, each is a double or repeated scale, the first scale ending in the middle of the slide rule and the second beginning at the same place.

One advantage of the A, B scales is that in performing operations with them, the result can always be read, since if the index of B goes beyond the right index of A, it has the repeated A scale above it and the result can be read directly. Proportion problems can always be solved and the results always read by use of these scales. The chief disadvantage of these scales lies in the fact that the smaller spaces between the major divisions do not allow the same degree of subdivision as the C and D scales do, and hence a result cannot be read so accurately on the A or B scale as on C or D.

**SQUARE ROOT**—The distance, expressed as a decimal of the length of the scale, from the left index to any number printed on the scale represents the mantissa of the log of that number. The A and B scales are one half as long as the C and D scales and since doubling the log of a number, gives the log of the square of the number, it follows that

- 1 Any number on the A scale is the square of the number below it on the D scale.
- 2 Any number on D is the square root of the number immediately above it on A.

These facts lead to the following rules

- 1 To find the square root of a number pick it out on the left half of the A scale if the number has an odd number of digits to the left of the decimal point. If it has an even number of digits to the left of the decimal point, pick it out on the right half of A scale.
- 2 Set the hair line of the runner over the number thus picked out. Under the hair line on D read the square root.
- 3 To find the square of any number pick out the number on D. Set the hair line of the runner over it. Under the hair line on A read the square of the number.

**Example 1** Find the square root of 9. Setting the hair line of the runner over 9 on the left half of the A scale, under the hairline on D read 3.

**Example 2** Find the square root of 26. Set the hair line over 26 on the right half of A. Under it on D read 5.1 approx.

**Example 3** Find the square root of 325. Set the hair line over 325 on left half of A. Under it on D read 18.03 approx.

**Example 4** Find the square of 54. When the hair line is set over 54 on D read on A 2.916.

**DIVIDING A SERIES OF NUMBERS BY THE SAME DIVISOR**—In setting up profit and loss statements it is frequently desired to express the figures on the statement as percentages of a constant figure, such as net sales or cost of sales. The same condition is often found in cost accounting, when it is necessary to make overhead distributions of expense factors (light, supervision, building maintenance, etc.). In these cases, it is possible to express each departmental allocation as a percentage of the total to be distributed. It is not, however, necessary to perform a separate long division for each distribution. By means of the slide rule, successive percentages are easily found with but a single setting of the hair-line. The figure for net sales or the total of the standing orders represents a constant divisor. The calculation is performed by setting the hair-line over the constant divisor on the D scale. Move the slide to bring each dividend in succession under the hair-line, to find what per cent each is of the common base. The quotient, or per cent, is found by reading upward from the index of D to the quotient on C.

**Example** Find what per cent of net sales each of the following items represents:

Net sales	\$450,000
Cost of goods sold	240,000
Selling expense	32,500
General expense	8,200

Setting the hair line over 45 on D, first move the slide to the right to bring 240 under the hair line. Above right index of D read on C the digits 546. Cost of goods sold is 54.6% of net sales. Now move slide to bring 325 under the hair line. Above the right index of D read 722 which is 0.722 or 7.2% of net sales. Next moving the slide to bring 82 under the hair line above left index of D read 182. General expense is 0.182 or 1.8% of net sales.

**THATCHER SLIDE RULE**—The chief limitation of the ordinary slide rule lies in the fact that in the upper part of the scale only three digits can be determined with accuracy. To overcome this objection the Thatcher slide rule was developed. This is a cylindrical slide which enables the operator to use a slide rule of great length, cut into equal sections, and reproduced in succession on the surface of a cylinder. This great length of the complete logarithmic scale allows much greater subdivision of the upper part of the logarithmic scale, so that always four digits of a result can be determined, and in most cases five digits can be read.

The operations are performed essentially as with an ordinary slide rule. Once a ratio has been established, proportional distributions can be made by a single setting of the slide rule at this ratio.

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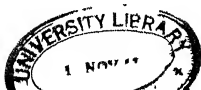
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